the glass industry
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The Glass Industry—1958

By H. E. SIMPSON
College of Ceramics

State University of New York
Alfred University, Alfred, N. Y.

I—INTRODUCTION

During 1958 the glass industry enjoyed high production in some divisions and suffered from low production in others. Flat glass, comprising window and plate glass, was rather disappointing owing to a depressed automobile market, coupled with serious strikes during the fourth quarter. This combination of circumstances resulted in a decrease of approximately 10-15 per cent below the 1957 production level.

The effects of imports of window and plate glass still harass the industry, and it is especially disappointing to note that Congress has renewed the Trade Agreements Act permitting further tariff reduction. However, the future is not entirely disappointing, especially because the building and automotive industries promise to provide increasing orders for these types of glass.

Shipments of glass containers, on the other hand, have continued at a high level, and 1958 will undoubtedly equal 1957, which was a very good year for container production.

Impressive growth records were also made in glass fibers and electronics. The sales volume of glass fiber is estimated to be over $225,000,000. With the exception of a decline in the demand for glass by the television industry, the need for glass for technical and industrial uses continued high.

Last year will be especially remembered as the 350th anniversary of the founding of its first industry—glass blowing. The second ship to arrive at Jamestown, Virginia, carried eight skilled glass workers, who set to work early in 1608 under the direction of Captain John Smith to build what he called a "goodly glasse house" in a wood about a mile from that settlement. Equipped with four furnaces made of rough boulders, it turned out vials, bottles, and drinking glasses, along with a considerable quantity of beads for trading with the Indians. The little factory was reconstructed this year as part of the Jamestown Festival activities.

The year 1958 has also been distinguished by the construction and operation of a number of new plants and expansion of old ones. On the assumption that demand for bottles will continue strong, container manufacturers have been expanding.

Owens-Illinois, for example, recently opened its 13th plant—in Atlanta, Georgia—and the company's international division has two container plants under construction in Cuba and Venezuela.

Continental Can is busy rejuvenating the production facilities of the Hazel-Atlas Division, acquired 14 months ago in a merger. Outlays last year came to $6.9 million, and in August a new plant was opened near Chicago.

Pittsburgh Plate Glass Company dedicated its new mile-long plate glass factory at Cumberland, Maryland, and the plant is now in full operation. Highly mechanized, the new unit employs the twin-grinding process in which both surfaces of the glass are ground at once. In addition, the new Harmarville Laboratory is in partial operation; there is a new fiber glass plant at Shelby, North Carolina, now nearing completion; a new window glass plant at Decatur, Illinois; and a glass-tempering

plant at Crestline, Ohio, also near completion. Fiber glass production facilities have been expanded at the Shelbyville, Indiana, plant.

Libbey-Owens-Ford Glass Company is now constructing a new Engineering building at its Technical Center in Toledo which will nearly double the space devoted to Engineering, Research, and Development operations.

L-O-F is somewhat removed from glass fiber developments now since it is merely a controlling stockholder in L-O-F Glass Fibers Company, which is soon to be taken over by Johns-Manville Corporation through an exchange of stock. This transfer will probably take place the early part of January, 1959. The preliminary agreement has been signed but must be ratified by shareholders of L-O-F Glass Fibers.*

The company has awarded the contract, and work has started, on a new 15-story office building to house Executive Offices in Toledo. It will be a curtain wall structure of glass, situated in a large area in downtown Toledo. Libbey-Owens-Ford will occupy more than six floors in the building and will have additional space to rent.

The year has also seen the opening of two new Corning plants, one in Big Flats, New York, for the production of laboratory apparatus, and the other, in Bradford, Pennsylvania, for the production of electronic components.

Owens-Corning Fiberglas has a subsidiary company, Vitro-Fibros, S. A., in South America, which has completed a modern plant for the manufacture of Fiberglas insulation and building materials. It is now moving ahead to build Fiberglas textiles. A plant for producing Fiberglas textile products in Japan has also been completed. The company is known as Asahi Fiber Glass Company.

The American-Saint Gobain Corporation was organized May 27, 1958, by the merger of American Window Glass Company and Blue Ridge Glass Corporation. The latter company was a wholly-owned subsidiary of Societe Anonyme de Manufactures des Glaces et Produits Chimiques de Saint Gobain of Paris, France, whose history dates back to 1665 when the company was founded by Louis XIV of France. The new company, known as American-Saint Gobain Corporation, was organized with the basic objective of adding a plate glass manufacturing facility, thereby creating a third, full-line producer of flat glass products in the United States.

It would appear, therefore, that the glass industry is ideally prepared to meet any increased demands for production the future may bring.

II—FLAT GLASS

Flat glass sales during the first half of 1958 were down about 22 per cent from 1957. This decline was due to reduced requirements in the building and automotive fields. The third quarter of the year, which included vacation shutdown periods, showed a reversal of sales trend in August and September.

The fourth quarter, which was expected to bring back the total volume for 1958 to a fairly good year, was harassed by strikes. The result has been a disappointing year, somewhat lower in production than 1957.

Another discouraging trend in the industry has been the impact of foreign competition, especially on coastal areas. The renewal by Congress of the Trade Agreement Act permitting still further reductions in tariff promises to depress the industry even further. It is hoped that increases in the demands of both the building and automotive industries, coupled with the improved ability of the industry to produce, will make 1959 a more productive year.

The year 1958 has been distinguished by marked plant improvements either in the form of new plants and equipment or rehabilitation of older plants. Some of the improvements are as follows:

Cumberland, Maryland, Plant (Works 7), Pittsburgh Plate Glass Company

This brand-new plant, located along the Potomac River about six miles below Cumberland, Maryland, is geared to produce polished plate glass for use principally by furniture and mirror manufacturers and the construction industry. Production capacity of the new unit is estimated at 50,000,000 square feet of polished plate glass a year.

Its continuous production line includes many advanced scientific and engineering developments which mark a new era in plate glass manufacturing technology. From the automatic weighing and mixing of raw materials to the intricate cutting and packing lines, especially designed automatic equipment plays an important role in maintaining highest quality production. This advanced technology and "Pittsburgh's" 75 years of glassmaking experience are combined to assure maximum efficiency in the high-speed production of plate glass.

From the cooling area the continuous glass ribbon enters a battery of giant twin-grinders which incorporate the most advanced plate glass grinding techniques. In these, both surfaces of the glass ribbon are precision ground at the same time to give the glass maximum optical quality. The grinding heads are 11 feet in diameter and weigh approximately 8,000 pounds. The grinding material is specially processed silica sand.

A complicated grading system separates the sand into 14 different sizes for feeding to the grinding units. In the first units, sand particles are about 24 thousandths of an inch in diameter; in the last one they are less than the size of pinpoints. After being perfectly ground, the glass is automatically cut into plates 15 feet long, which then move on a conveyor to the polishing lines.

The polishing system at Works 7 includes many innovations which are designed to increase polishing speeds appreciably. Operations begin by transferring the ground plates from the conveyor to an endless moving line made up of cast iron "tables" covered with a cloth that holds the plates firmly in place. These "tables" move under a series of polishing bridges. Each bridge has nine rotating blocks which use a solution of water and rouge to polish the ground glass to a transparent finish.

After one side is polished and washed, a vacuum crane lifts the plate to a conveyor which moves it to a "barrel" turnover. This automatically receives the glass, reverses it, and sends it to the second polishing line where the other side is processed. All operations are continuous.

Some of the production of Works 7 will be processed

* See page 30 of this issue for a full account of the merger between Johns-Manville Corporation and L-O-F Glass Fibers Company.

by mirror manufacturers or fabricated into double-glazed picture windows. A portion of the glass will be processed at other company plants into special glass products such as protective screens in factories and sports arenas, electrically conductive glass for windshields for aircraft, ships, and trains and for many other applications.

Decatur Window Glass Plant, Pittsburgh Plate Glass Company

The general construction contract has been awarded for a multi-million-dollar window glass plant about four miles southeast of Decatur, Illinois, on an 80-acre farm site. General contractor will be Virginia Engineering Company of Newport News, Virginia. Approximately 350 employees will operate the new plant.

The Illinois site was chosen because it is strategically situated near the large St. Louis and Chicago markets and because it will permit prompt service to the sash and door fabricators along the Mississippi River and its tributaries. Availability of adequate gas supplies, and proximity to high-grade silica sand and other raw materials required in window glass manufacture also contributed to the selection.

The unit will contain approximately 450,000 square feet of manufacturing and storage space. Planned production includes all commercial thicknesses of window and sheet glass.

Initially, the plant will have one glass tank and four Pennvernon drawing machines. The glass tank will be larger, and the four glass ribbons produced by drawing machines will be considerably wider than those in older Pittsburgh Plate window glass factories.

Glass Research Center, Harmarville, Pennsylvania, Pittsburgh Plate Glass Company

Occupation of this modern research center was begun last spring. The development and product control building, first of the two structures to be erected, has an area of 170,000 square feet and is designed with a high bay for accommodating pilot plant equipment and providing ventilation over high-temperature areas such as tanks and furnaces. It has an area 480 feet by 260 feet and possesses movable partitions in the shop locations.

A single-story structure, the development and control building includes a mezzanine floor for offices and laboratories. The basic research building is a glass-clad structure of six floors with 70,000 square feet of floor space. This structure contains chemical, physical, and analytical laboratories, plus administrative offices and a library. It also features movable partitions and has a connecting passageway to the development building.

Crestline, Ohio Plant, Pittsburgh Plate Glass Company

Pittsburgh Plate Glass Company will construct a multi-million-dollar glass fabricating plant on a 49-acre site at Crestline, Ohio. Site preparation for the factory containing 275,000 square feet of floor space has already begun. Scheduled for completion in 1959, the structure will be one story with glass and pre-cast concrete walls. Much of the equipment for the factory has been developed by the glass division's research laboratories and engineering department. Crestline was selected for the plant location because it is between the source of glass supply at Mt. Vernon, Ohio, and major automotive customers.

Executive Office Building, Libbey-Owens-Ford

Dramatizing the company's flat glass products, the building's four walls will be entirely encased in glass framed by aluminum. Thermopane insulating windows will be unusually large, approximately 6 feet wide and 10 feet high, and the sprandrels will be of Vitrolux, a heat-strengthened glass with vitreous color fire-fused on the back surface for permanence. The building will be fully air conditioned, will have luminous ceilings, movable partitions, and vertical blinds for light control. Floors will have vinyl plastic coverings. There will be no stores on the ground floor—this area will be entirely devoted to lobby, telephone exchange, and five high-speed elevators. The two top floors will be given over to mechanical equipment, chiefly the air conditioning system and network of ducts.

During 1958 Libbey-Owens-Ford moved to speed shipments of replacement automotive glass to distributors and dealers by constructing a new warehouse at its East Toledo plant. The warehouse is 360 feet wide and 460 feet long with 20-foot overhead clearance. It has approximately 100 storage bays, each 40 feet square, which will be used for rapid selection of various parts carried in the inventory. A depressed railroad connection, which can park six railroad cars, and docks for six motor trucks facilitate the movement of stock in and out of the warehouse. Fork lift equipment is used throughout. A monorail crane in one bay serves trucks.

Larger windshields and their intricately curved design require greatly increased storage and handling space, as compared with the small, flat windshields or block-sized laminated glass of a few years ago. Cartonizing equipment has been put in the new warehouse so that jobbers may be served either with the conventional production packs of 20, 25, or 30 windshields, smaller packs of eight windshields or individual windshield parts cartons. Block sizes of flat safety plate and safety sheet glass will also be cartonized in packs of six lights each for shipment to jobbers. The warehouse is 1,100 feet south of the two large plate glass melting furnaces at East Toledo so that it relieves the bending, laminating and packaging facilities in the production area from interference or congestion.

Plate Glass: New Developments and Products

The biggest development of 1958 is undoubtedly the larger use of safety glass in automobiles. The 1959 automobiles will have from 35 to 50 per cent more glass area than earlier models. The windshields will be larger and have compound curves blending into the top. As optional equipment, there will be offered a shaded rear window to reduce the glare and solar heat entering the car through the glass. This product is a solid safety plate product with the shading added as a coating. All windshields, of course, are laminated safety plate glass with the shading put in as a dye treatment of the plastic interlayer. The windshield shading is now a neutral blue color which enhances reds and yellows, does not alter the

greens, and also gives the interior of the car the effect of the blue of the sky.

Improved Double-Glazing

Because of the architectural interest in its new Solargray Plate Glass, Pittsburgh Plate Glass Company now has Solargray Twindow double-glazed insulating glass units in sizes up to 50 square feet. The new Twindow product will be available in metal edge only. It is made of ¼ inch Solargray plate glass and ¼ inch regular plate glass with either ½ inch or ¼ inch air space.

The principal uses for the new Twindow units are for sunny elevations overlooking bright objects, in residences, apartment buildings, hotels, motels, banks, schools, or any building application in which open design requires the thermal insulation Twindow plus the glare reduction and heat excluding properties of Solargray plate glass.

Super Safety Glass in Boeing 707 Jet

Specially fabricated safety glass windshields providing features not previously thought possible for commercial aircraft are incorporated in the new Boeing 707 Jet being introduced to intercontinental service by Pan American Airways.

The new one-inch thick Nesa Flexseal glass (Pittsburgh Plate Glass) windshields used in the pilot's enclosure of the new jet are engineered to provide maximum safety under flight conditions and speeds greater than those ever encountered by commercial aircraft. All the glass in the pilot's enclosure provides, in addition to superior optical qualities, electrical de-icing by means of PPG's transparent electrically conductive coating "Nesa" and complete safety at operating pressures at 40,000 feet and speeds over 600 miles per hour.

The windshields are designed to meet CAA bird resistance requirements at climb speeds never previously encountered by commercial aircraft. Ten of the special Nesa Flexseal windows comprise the pilot and co-pilot enclosure of the 707 Jet providing unexcelled vision, including two curved "eyebrow" windows above the pilot and two above the co-pilot for overhead visibility.

Brightness Control Glass

A new gray sheet glass for building areas which require brightness control has been developed by Pittsburgh Plate. The new glass, Pennvernon "Graylite", was designed specifically to meet the need of the architectural field in controlling light environment. It will be manufactured in two thicknesses, ⅛ inch and 7/32 inch.

The ⅛ inch glass will provide a visible light transmittance of 31 per cent. The 7/32 inch sheet provides visible light transmittance of 13 per cent and a radiant energy transmittance of 45 to 50 per cent, which meets the requirements of Federal specifications for heat-absorbing glasses.

Table I shows the production and shipments of flat glass for the first three quarters of 1958. Estimates are also made for the entire year.

TABLE I

Flat Glass—First Three Quarters 1958

Production and Shipments*

	PRODUCTION[1] (Quantity)	SHIPMENTS (Quantity)	SHIPMENTS Value ($1,000)
Sheet (window) glass (not rolled) including colored:	(1,000 boxes of 50 sq. ft. each single strength and equivalent)		
First Quarter	5,374	4,286	22,545
Second Quarter	4,212	4,056	21,116
Third Quarter	4,774	5,369	27,497
Total	14,360	13,711	71,158
Estimated (by author) 12 months 1958	16,500	18,000	
	1,000 square feet		
Plate and other flat glass:[2]			
First Quarter	133,195	54,016	24,672
Second Quarter	99,108	49,807	23,005
Third Quarter	174,694	66,998	30,099
Total	406,997	170,821	77,776
Estimated (by author) (12 months 1958	500,000	225,000	

* Source: "Facts for Industry"—U. S. Department of Commerce.

[1] Production figures include the quantities shipped as well as the quantities incorporated into other products manufactured by establishments producing glass.

[2] Includes data for wire and rolled glass, translucent, opaqued, roughed, or otherwise impressed. Excludes information for block and tile, and glass blanks.

III—CONTAINER GLASS

Last year, for the fourth successive year, U. S. shipments of new glass containers reached a very high level—actually within two or three per cent of the record high in 1957. Shipments of new glass containers are estimated to be about 136 million gross or 19.6 billion units. On the basis of past trends, it is predicted that by 1975 glass companies will be making at least 47 billion containers. Shipments of new glass containers for the first 8 months of 1958 and 1957 are compared in Table II on page 17.

During the past seventeen years—including 1957—glass container shipments have increased faster than either population or disposable consumer income.

Though it is not generally realized, the packaging industry is the nation's ninth largest. Its annual dollar volume is exceeded only by such giants as the automotive, petroleum, and aircraft industries. The steel industry ranks eleventh. Over $10,000,000,000 was spent on a total of more than 600 billion packages in the United States in 1957.

In the same year the country's 41 glass container manufacturers shipped 20.2 billion units, or 118 glass containers per capita. This is an increase of 2.0 per cent over the previous high of 19.8 billion units established in 1956.

Many purchasers re-use the same bottle again and again. The average number of trips made by milk bottles

is 32; soft drink bottles 25; and beer bottles 21. Since statistics are available covering shipments of closures used on returnable glass containers, an accurate estimate of total sales of glass-packed units in the United States is possible. The figures show that in 1957 some 74.9 billion jars and bottles—or an average of 440 per capita—"went to market" in the United States.

End Use

Almost all of the 41 container manufacturers produce the many different container styles used in packaging. While literally thousands of different consumer products were packed in the 20.2 billion containers of 1957, all these items can be catalogued for convenience in one of four general end use categories: Food, beverage, drug and cosmetic, and chemical (See Table III).

Gallo Glass Company

This new company, in Modesto, California, has gone into production of wine bottles exclusively, and several others have increased manufacturing capacity by adding furnaces or by modernization of equipment.

Gallo Glass Company has a melting capacity of approximately two hundred tons of glass per day, serving six production lines. The glass being produced is said to be a new color and composition for the American glass industry. It is a dark yellow-green, similar to some European wine bottles, but is reported to be superior in protection of product from harmful light rays. All of the bottles are being supplied to the E. & J. Gallo Winery.

Improved Melting Techniques

Large regenerative furnaces have shown increased efficiency and longer life during 1958. One furnace completed a campaign of a little more than five years at an average fuel consumption, equivalent to about six million BTU per ton. This is nearly twenty-five per cent below usually accepted fuel consumption. This furnace is not unique, but does represent modern design, good application of refractories, and excellent control of operating conditions.

Interest has grown in a method of stirring glass in the furnace known as "bubbling." A small volume of compressed air is introduced through multiple openings in the bottom of the furnace. The reports indicate improved quality of glass, although there have been no published results.

Changing the color of glass by addition of coloring materials to one forehearth of a furnace has been a subject of considerable interest. Little is known regarding the extent or success of the various methods proposed or actually used. It is understood that the color change is limited for most practical uses to changing or modifying the color of flint or "colorless" glass so as to change slightly the character of the "colorless" glass, or to produce a light green or light blue product.

There have been no major advances in feeding, forming conveying, or annealing of glass, although there have been the expected refinements of process and equipment, resulting in increased efficiency of operation.

Direct-Fired Unit Melters

The small direct-fired, glass melting furnaces known as Unit Melters have continued to be used for additional melting capacity, for special colors or composition, and for small plants located close to the packing house or bottler. The total of such furnaces in the United States is now twelve, with one or two more to be added soon. The total throughout the world is sixty-one, most of them displacing, or successfully competing with, older types of regenerative and recuperative furnaces in areas where fuel costs are high, but daily output performance is less than fifty tons.

Up to the present, the melting capacities of Unit Melters have covered a range of from less than ten tons to a maximum of forty tons of glass per day. During this year a new, larger Melter for fifty to sixty tons of glass has been designed. Other improvements include

TABLE II

Shipments—8 Months 1958/1957*

(Figures are expressed in thousands of gross)

	1958	1957	Per cent Change
All Types, Total	95,196	98,969	— 3.8
Direct exports	1,868	1,866	+ 1.0
Domestic	93,328	97,103	— 3.9
Narrow neck, Total	57,559	60,458	— 4.8
Food	9,502	10,302	— 7.8
Medicinal and Health	10,617	11,171	— 5.0
Household and industrial	6,444	7,119	— 9.5
Toiletries and cosmetics	6,622	6,865	— 3.5
Beverage—returnable	6,485	6,516	— .5
Beverage—nonreturnable	934	992	— 5.8
Beer—returnable	2,336	2,053	+13.8
Beer—nonreturnable	5,958	6,205	— 4.0
Liquor	5,901	6,282	— 6.1
Wine	2,760	2,953	— 6.5
Wide mouth, Total	35,769	36,645	— 2.4
Food†	27,646	27,460	+ .7
Medicinal and health	3,139	3,509	—10.5
Household and industrial	1,269	1,562	—18.8
Toiletries and cosmetics	2,157	1,964	+ 9.8
Dairy Products	1,190	1,483	—19.8
Packers' tumblers	368	667	—44.9

* Source—"Facts for Industry", Department of Commerce
† Including fruit jars and jelly glasses

TABLE III

End Use of Glass Containers—1957*

	Gross	Units	Percentage of Total Shipments
Food	57,896,000	8,337,024,000	41.4
Beverage	34,603,000	4,982,832,000	24.7
Drug and Cosmetic	35,230,000	5,073,120,000	25.2
Chemical (Household and Industrial)	12,223,000	1,760,112,000	8.7
TOTAL	139,952,000	20,153,088,000	100.0

* Glass Container Manufacturers Institute

the addition of simple heat-recovery systems and improved application of insulation.

Automatic Inspection and Testing

Considerable development work has gone into tests and experiments aimed at improved automatic inspection or testing of glassware.

A number of lehrs have been equipped with a device for administering a thermal shock, or heat test, to ware as it leaves the annealing zone. This device has been particularly useful in improving the quality of beverage bottles and beer bottles by removing certain types of imperfections that otherwise are difficult to eliminate. This same system of thermal shock has been extended successfully to the testing of jars and other types of bottles.

The use of automatic equipment for gaging the bore of narrow-neck bottles has increased, and several improved devices are being used, or tested, for this purpose. Such testing eliminates an extremely small number of bottles which can cause a great deal of trouble in high-speed filling lines.

Equipment for detecting checks or small cracks in the sealing surfaces of jars has been improved.

One hundred per cent visual inspection of the ware before it is packed is followed by nearly all, if not all, manufacturers. The use of equipment for marshaling ware into one or more single files has increased as improved results have been reported from single-line inspection. This system allows a combination of visual and automatic inspection methods to be used to best advantage. Ultimately, it would appear, a large proportion of glass containers will be tested, inspected, and packed by automatic means. There are at present some very close approaches to this goal in specialized production.

Decoration for Containers

Since the products of the cosmetic industry are concerned chiefly with the ingredients of "beauty" and of catering to the dictates of good grooming, the versatility of design and decoration provided by glass becomes highly important. Glass containers may be manufactured in a multiplicity of shapes, designs, and contours. These design characteristics may be utilized to enhance the display of the product, stimulate impulse-buying appeal and offer consumer convenience.

The cosmetic packager will have a greater choice of labeling methods than is found in other industries. Glass containers can be decorated with an over-all spray coating of ceramic colors to produce anything from a frosted surface to various shades of opaque and translucent colors.

It is also possible to decorate the surface with metallic coatings resembling gold, silver or copper, or with various pearlescent effects. In addition to the over-all coatings, a secondary color can be applied by silk screen or random spray veiling.

Generally, the use of applied color labels "ACL" is limited to pressure beverage ware, milk bottles, and containers for toiletries and cosmetics. The use of automatic equipment for printing labels in one or two colors has increased. Speeds of such equipment range from seventy to nearly one hundred per minute with some talk of further developments increasing speeds to one hundred fifty per minute.

The increase in use of automatic equipment for application of ceramic labels on glass has resulted in demand for increased productivity and accuracy of control in decorating lehrs. These problems have not been fully solved, but considerable progress has been made.

Surface Coatings for Containers

It is generally agreed that the strength of a glass container lies in its surface and that the path to improving glass-container strength leads in the direction of preserving its surface. As a result, much work has been done to develop surface coatings which will preserve the virginity of the glass surface.

"Wax" coatings, such as stearate and glycol, are primarily lubricating in their action. They do not change the surface of the glass chemically, as does the sulphur coating. These wax coatings effectively reduce surface scratching, as long as the bottle surface is dry; however, these coatings are readily removed by washing and lose their lubricating properties when wet.

Silicone coating, which is considerably more efficient in the mechanical bond it forms between the coating and the glass surface, has some protective effect on the surface of a container even after a rinsing or washing operation. In contrast with the sulphur and "wax" coatings, the silicone retains its lubricating property when wet.

Recently a multi-purpose coating was announced that employs a water-insoluble organic polymer; reportedly, it is a form of polyethylene. Silicones have also been used in interior coatings, particularly in pharmaceutical vials and bottles, to reduce clinging of the product to the glass and to make sure the full contents are discharged.

Thatcher researchers recently came up with a process called "Nu-Glass," by which returnable bottles are given a renovating finish when they go back to the bottler. It is said to cut in half breakage on the filling line, and to permit higher filling speeds.

Operational Economies

Introduction of automatic batch weighing, mixing and handling has produced economies and has eliminated "cords" which, while usually invisible to the eye, affect the homogeneity of the glass. Advanced instrumentation and changes in furnaces have also contributed to greater homogeneity.

Improved heat transfer in the molds has permitted better distribution of the glass, producing lighter weight and stronger containers. Most glass containers are one-third lighter than they were 30 years ago. About 75 per cent of the weight reduction per cent is attributable to improvements in the machine itself and 25 per cent to improvements in melting.

Although less glass is now being used in the modern container, the manufacturer has achieved improved thermal shock strength, impact strength, and internal pressure strength.

Operating economies have been effected by the glass companies through increasing the number of molds per machine, double gobbing (where two bottles are made simultaneously in twin molds), and increases in the ma-

chine speeds. Machines now produce as many as 250 bottles per minute, as compared with only 30 to 40 bottles per minute some 25 years ago. Speeds ranging up to 700 or more units per minute are believed practical.

One of the largest areas of labor cost in production of glass containers is at the cold end of the lehr, where they are inspected and packaged for shipment. Additional cost reductions are now being made by means of "straight line" inspection before an electric eye and automatic casing machines.

In warehousing containers, there has been increased use of palletizing, along with improved methods and equipment. By a relatively new system, all palletizing is performed at a central station connected to all shops in the factory by means of an elaborate conveyor that is automatically controlled to deliver pallet loads of filled cartons from each shop.

Liquor Packaging

Perhaps the most striking development in liquor packaging in recent years has been the widespread use of decanters during the holiday season. Because of their seasonal character, only a small percentage of the total amount of liquor packaged goes into these specialized containers.

There are some indications, that the use of these special decanters may have reached its peak. A number of distillers are now using for the holiday season "gift wrapped" packages incorporating their regular bottles. If this trend continues to grow, the holiday decanters for packaging liquors may well decline.

Lighter-weight bottles

In the liquor and malt-beverage industries there has been a definite trend toward lighter-weight bottles. During the late 1940's, as sales became more and more competitive and costs of labor, supplies, and services increased, distillers and brewers began to seek methods of reducing their costs. This was one avenue they explored.

100th Anniversary of Mason Jar

November 30, 1958, marked the 100th birthday of the Mason jar, and this long-famous and familiar glass container now has entered its second century as modern as it is historic. The ancestor of all glass containers with screw-on tops, the Mason jar is today a household article in literally millions of U. S. homes.

It was in 1810, forty-eight years before John Landis Mason patented his jar on November 30, 1858, that Nicolas Appert, a French confectioner, published his principles of food preservation through sterilization. Appert's theory was that heat would preserve fruits, meats, fish, and vegetables by arresting the natural tendency of foods to spoil. After fifteen years of experimentation, Appert was awarded a 12,000-franc prize by the Emperor Napoleon himself.

The pioneer in food preservation had chosen glass containers because, he said, it was the packaging material most impervious to air. However, it remained for John Mason to perfect a glass container that could seal in the harvest-time freshness of fruits and vegetables.

People like glass containers because glass never adds to—or takes away from—the taste of the foods or beverages they contain.

This same neutral character of glass, its relative chemical inertness, is one of its primary assets in many other applications. Glass may be used to transport the most corrosive chemicals and the strongest acids for indefinite periods. Some glass carboys made over fifty years ago are still in daily use, it is reported, doing their job just as well as the day they were made.

IV—FIBER GLASS

The glass fiber industry suffered a mild recession early in 1958, but stronger demands for building materials and the general upturn of business helped to bring it back to an impressive level. Sales for the entire industry are estimated in excess of $225 million.

Capital additions have recently been made to various plants of Owens-Corning Fiberglas Corporation. At Anderson, South Carolina, the company has integrated production facilities with a new glass melting furnace batch plant along with manufacturing areas. New equipment for materials handling and glass melting was put into use at the Ashton, Rhode Island, plant.

The new general products plant at Barrington, New Jersey, has been completed with a process for manufacturing highly superior residential building insulation, a general line of light density products, and equipment for producing an improved form of pipe covering.

As part of a major rehabilitation program at Newark, Ohio, a modern factory to house large glass-melting furnaces and insulation forming machines has been erected around the old structure, which was then removed without interruption of operations. A further step undertaken for 1958 expands electric power facilities to support increased mechanization and process improvements.

Additional equipment has been provided at Newark, Ohio; Kansas City, Missouri; and Santa Clara, California, plants for production of large-size acoustical products. A new unit at Kansas City to produce roll roofing materials is under construction. At Santa Clara facilities for increased production of roll roofing have been made and a new warehouse completed.

Ground was broken early in the year at Shelby, North Carolina for Pittsburgh Pate Glass Company's continuous fiber glass yarn plant, one of the world's largest fiber glass yarn producing operations. Construction work on the plant, a one-story structure with more than 350,000 square feet of floor space, began in early spring.

Research and Product Development

Basic research and continuing product and process development have been the cornerstones for progress in this industry. During the past year decentralized operations in the fields of research and development have begun to show results in terms of new and improved products and processes.

AF (All Fiber) Process

Units employing an AF (All-Fiber) process are now in operation at three plants, and with it Owens-Corning is producing a completely fiberized insulation. With a foil-faced vapor barrier, it sets an entirely new standard in home insulation performance. Its resilience is such

that it can be compressed in packages ⅔ to ½ the size of those previously used, thus affording space savings in transportation, warehousing, and in handling costs for both the corporation and its customers. This AF-type insulation has also been introduced to the transportation and appliance fields on a limited basis, and, as capacity becomes available, it is expected to be widely adopted with advantages similar to those it affords in home insulation. Future development may make it a superior and economical material for high-density boards for various construction purposes.

Access Acoustical Tile

Access Acoustical Tile has been made available for suspended ceilings and lines of large size tiles (2′ x 2′ and 4′ x 4′ and special sizes) in several textures and designs. These were developed in response to a long-unfilled architectural demand for patterns and sizes better suited to today's decorative and structural concepts. In addition, improvements have been made in all acoustical product lines with the development of washable, durable finishes.

Also available are new "U-Trim-It" air filters that can be cut to fit air conditioning units of various sized and kinds, in convenient, easy-to-handle packages.

Roll Roofing

Roll roofing mat for built-up roofs, developed on the Pacific Coast several years ago and introduced to the Eastern market during the past year, is following the pattern of acceptance and excellent performance established in the Western States. The Pacific Coast Division of Owens-Corning introduced during the year new mineral surfaced and smooth-surface roll roofing. Facilities for producing this line of products for Eastern markets will soon be in production at Kansas City.

Fiberglas Flake

Fiberglas Flake is now being made up in a flake-glass paper product to replace mica and other flexible insulations. This flake has superior handling qualities for use in electrical equipment and is now in experimental applications. Fiberglas Flake is also being experimentally fabricated in combination with plastics into light-diffusing panels with qualities of low glare, high efficiency, lightweight, high strength, and attractive appearance.

Textured Yarns

Textured yarns have been introduced in new Aerocor fabrics. The fabrics are of soft, linen-like textures with unusual design properties. They will not wrinkle or muss and can be quickly and easily washed and rehung.

Screening, introduced commercially last year, is now challenging older materials in the field. This development in coated yarns has led to experimentation in waterproof webbing, outdoor furniture, and for use in reinforcing mechanical rubber goods such as belting, and high pressure hose.

Reinforcement for Paper

Use of Fiberglas in various forms as a reinforcement for paper—dimensional stability, greater tear strength toughness—is gradually expanding, and during the year was introduced in matrix and filter papers.

Small Boats of Glass Fibers

Glass-fiber reinforced plastics have continued to increase their position in the small-boat field. Recent surveys indicate that approximately 25 per cent of all outboard motorboats are now built with FRP hulls. Techniques of fabrication have been developed for larger boats, including cruisers and sailing sloops as large as 40 feet, Navy landing craft, Coast Guard vessels, and life boats.

Outboard motor shrouds, lawn mower housings, tractor, truck and bus component parts, phonograph and television cabinets, postage meter housings, school seats, and various types of containers are among the developments that are now in commercial production or are being field tested. Highway guard rails and bus seats are among new uses that are presently being evaluated.

High Temperature Glass Applications

High-temperature glass for application alone, or in combination with plastics, to meet jet and supersonic speed and heat resistance requirements has been recently introduced, and further developments are being carried on for defense applications. Work is also being done in metal and glass combinations.

Fiberglas insulation was used in the nation's first full-scale atomic power-generating plant recently brought into production. Fiberglas reinforcement in honeycomb structural form is incorporated in the supersonic B-58 and other aircraft. A release from the Defense Department indicates that our country's first satellite, "The Explorer," now circling the earth, has its instrument-carrying frame and coupling rings made of Fiberglas-reinforced plastic.

Comfort-Conditioned Home Program

Also recently announced was a Comfort-Conditioned Home Program, the most comprehensive marketing campaign in the history of glass fibers and an outstanding promotion in the interest of the home building industry. Preview of this Comfort-Conditioned Home Program and what it is designed to accomplish was presented by closed-circuit telecast from Washington, D. C.

An estimated 2200 leading representatives of the home building industry, including builders, contractors, architects, bank and mortgage officials, realtors, utility executives, appliance and equipment manufacturers, retail store executives, weaver and converter customers, and others—all with a stake in the $13-billion home building market—watched the telecast and were invited to participate in the program.

This campaign was the outgrowth of a test program initiated by Owens-Corning Fiberglas Corporation with the cooperation of electrical and gas utility companies, several years ago to determine whether a normal sized house (approximately 1200 square feet area) properly designed and insulated, located anywhere in the United States, could be weather conditioned the year around—heated in winter, cooled in summer—for an approximate operating cost of $10 per month. The test program is still underway, but in 126 houses in which readings have been

(*Continued on page* 38)

Investigation of Materials for Glass Container Molds

PART ONE: European Molds

By the Technical Staff
Emhart Manufacturing Company
Hartford, Connecticut

Editor's Note: This is the first in a series of articles on a broad program of research conducted by the technical staff of Emhart Manufacturing Company. Part One deals with a study of the action of glass on mold materials during the blowing and forming cycles. It covers an investigation of the metallurgy of glass container molds presently used in Europe.

EXPERIENCE INDICATES that the problem of finding an ideal mold material for glass container production is a complex one. In addition to the economic aspects, there are problems of metallurgy, heat transfer, sticking of glass to the mold, lubrication, and a host of others.

The chief requirements to be met by a mold material in order to guarantee a smooth run of bottle production have often been stated as: (1) resistance to progressive oxidation and scaling; (2) low specific heat and thermal expansion; (3) resistance to wear and thermal shock; and (4) resistance to growth on aging. Also, the mold must be easily machinable and must take on a good finish.

One can hardly expect all of these desirable properties to be embraced to the fullest extent in any one material. Thus, the selection of a mold material becomes a give-and-take proposition where one has to lose a little in certain respects in order to gain in others.

In the past, cast iron has been found to meet the average requirements as well as any other material, and daily production figures prove that good results are generally achieved with cast-iron molds. There is, however, a certain percentage of unsatisfactory performance. At times, cracks occur and there are chip-offs; the molds warp and often are damaged from the first moment they are used.

There are also problems connected with the behavior of the molds during cleaning and welding, unfavorable microstructure and porosity, and sticking.

Physical Principles

For mold stability under the strain of temperature cycling, and consequent expansion and contraction in rapid succession, thermal conductivity is of primary im-

Fig. 1. Blank Mold—Working Surface (230X)

Fig. 2. Blank Mold—Center (230X)

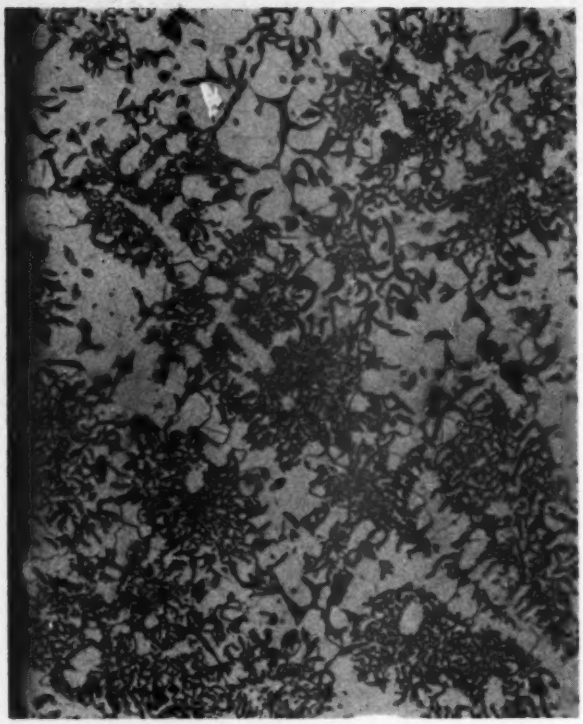


Fig. 3. Baffle—Working Surface (230X)

Fig. 4. Baffle—Center (230X)

portance. If the conductivity is high, the heat on the glass side of the mold will rapidly dissipate through the body of the mold and will finally be removed by air cooling from the outer surface. Such a mold will operate at a fairly low temperature, and hot spots may be prevented on the working face, especially if the mold is thick. A thin mold will, of course, operate at a higher temperature.

Essential structural differences between the working side of a cast-iron mold and the outside wall result in different coefficients of thermal conductivity, which must necessarily lead to internal tensions.

The coefficients of thermal conductivity of the principal structural components of cast iron decrease in the following order:*

Table I

Conductivity at 20°C

(a)	**Ferrite**	.18 Cal./cm²/cm/°C
(b)	**Pearlite**	.115
(c)	**Cementite**	Variable
(d)	**Graphite**	.057

While the extraction of heat from a mold is determined by the coefficient of thermal conductivity, it is interesting to consider what the difference would be between two cast irons of equal chemical composition but of the following structural difference:

(*a*) One having large graphite flakes linked together, forming more-or-less a wall of lower heat conductivity than the ferrite cells which they encircle, and

(*b*) One having graphite in nodular form, or in the form of small flakes not linked together, thus entirely surrounded by high-conductivity ferrite.

The stability of the microstructure is of importance for reasons of preventing volume changes. With a given operational temperature, no irreversible changes in the microstructure should occur by breakdown of structural components. In fact, it would be well also to eliminate any reversible volume changes, such as occur in pearlite if that constituent should be present in the iron.

Pearlite undergoes a sudden contraction when on heating it passes the temperature of 1350°F, followed by a sudden expansion when cooled through this same temperature. This volume movement during the operation of a mold results normally in premature heat cracking.

In operation, a mold surface may momentarily reach 1500°F. At this temperature, pearlite will, in time, break down to more stable components that undergo normal heat expansion without the volume changes at 1350°F. But by the time this occurs, damage may already have been done to the mold.

The pearlite to which reference is made, whether lamellar or spheroidal, contains iron carbide as a component. In alloy irons, containing strong carbide builders like chrome and molybdenum, we have a pearlite of higher transformation (hardening) point than 1350°F. In other words, if by proper alloying we can raise the transformation point of the iron beyond the normal operating temperature of the mold, we shall only have to

* The order in which graphite has been placed in this table may be disputed, as there is a question as to whether or not it should be placed above or below the cementite. The heat conductivity of the latter depends on whether it is true cementite (iron carbide) or some other carbide, such as chrome or molybdenum. It may be of interest to compare the figures in the table with the figure of .112 for cast iron.

deal with the normal heat expansion and contraction. We have avoided the additional sudden contraction and expansion at the so-called critical, or transformation, point which is recognized in hot work tools as being largely responsible for heat cracking.

In the above considerations pertaining to graphite flakes and transformation points it should be remembered that we are dealing with only one or two properties of the ten, or more, that make molds usable. All told, however, it is thought that the above is sound philosophy, and it indicates the direction in which some of our present research is directed.

Oxidation processes alongside the graphite flakes play a large part in the volume growth of cast iron. This occurs because the surrounding iron expands more when heated than the graphite component of the structure. This causes a loosening of the bond between the two and makes possible the penetration of hot gases and vapors from the mold lubricant and glass. Photographic evidence indicates that the penetration of these vapors takes place alongside graphite flakes with resulting chemical transformation of the iron walls.

If we were to draw a single conclusion from these findings, it would be that we should use a cast-iron mold material with small and short graphite flakes, or with graphite in nodular form, because the effect of hot gases would penetrate less deeply.

The phosphorus content in cast irons also deserves attention. Like silicon, phosphorus favors the splitting of carbide below the pearlite point, and at high temperatures, the precipitation of carbon from the solid solution. Above 1300°F the phosphide eutectic coalesces, the phosphorus diffuses into the ferrite, and the quantitative share of phosphide diminishes. As a hard component, phosphide has the tendency to emerge from the surface like an embossment, and may favor sticking. For this reason, a fine, narrow-meshed phosphide is preferable.

In the course of our research program, a great many molds, and mold parts, have been examined. Our study, being a broad one, has included examination of molds from Europe as well as those made in the United States.

Of interest is a chemical analysis, which was made of a blank mold, a baffle, a blow mold, and a blow head. These particular parts were of European origin and were used in an I. S. Machine until they were worn out. The molds were not cast against a chill, as is common American practice, nor were they alloyed to any appreciable extent. The analysis follows:

Table II

	C	Si	Cr	Ni	Mo	Cu	Ti	P
Blank Mold	3.56	2.20	0.07	0	0.04	0.10	0.11	0.44
Baffle	3.50	2.24	0	0	0.06	0.10	0.10	0.45
Blow Mold	3.60	2.19	0.06	0	0.05	0.14	0.11	0.43
Blow Head	3.74	2.29	0.08	0	0.06	0.10	0.13	0.42

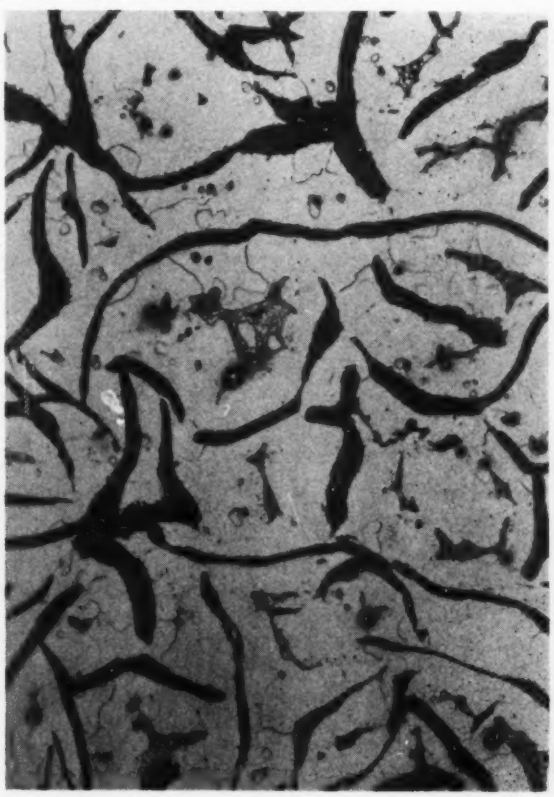
As is well known, most European iron ores are of a different character than American ores, and as a result European cast irons, in general, have a higher phosphorus content than American.

None of the molds or mold parts analyzed could claim outstanding service. The varying hardness values of the

(*Continued on page* 42)

Fig. 5. Blow Mold—Working Surface (230X)

Fig. 6. Blow Mold—Center (230X)



Nineteenth Conference On Glass Problems

• THE 19TH CONFERENCE ON Glass Problems was held on the Ohio State University Campus, Columbus, Ohio, on December 4 and 5 in spite of travel difficulties, airline strikes, and inclement weather. An excellent program was provided through the efforts and cooperation of H. H. Blau, Ohio State University; and Fay Tooley, University of Illinois. About 400 were registered, making this meeting one of the largest.

The group was welcomed to the Campus by Robert S. Green, Associate Dean of the College of Engineering, who pointed out the desirability of having such meetings on campus. The University's production problems, he said, are important to industry because educators are attempting to develop men competent to meet production problems in industry. He also emphasized the significant fact that Ohio as a state produces approximately 5 per cent of the gross product of the United States, has about 5 per cent of the people, and the University educates approximately 4 per cent of the engineers.

Air Pollution Problems

Dr. Blau was chairman of the morning session. The first paper was "Air Pollution Problems in Glass Manufacturing." by Roy S. Arrandale, Thatcher Glass Manufacturing Company, Elmira, New York. The rate of discharge of sum total weight of particulate and condensible matter (dust and fume) in the exhaust gases from bottle glass furnaces, both flint and amber, was discussed in some detail. The test method, together with the maximum discharge limits imposed by law in the county of Los Angeles, California, was discussed in particular.

The data collected indicated that the rate of stack emission is actually dependent upon furnace-operating temperature instead of process weight fed per hour. In material emitted, sodium and potassium sulfates are always predominant, whether these are deliberate batch constituents or not.

For purposes of rough estimation, at a rate of furnace pull of about 5 sq. ft. per net ton of glass per day, the emission of condensible and particulate matter from a flint bottle glass furnace will approximate 0.22 lbs./hr./ton/day for a normal batch with what would be considered normal amounts of flint oxidizers. If the oxidizers and other minor ingredients are cut to a bare minium, on the point of being deficient, this figure drops to about 0.14.

Amber glass produces less of the volatile matter and is about 0.12 lbs./hr./ton/day. To lower this figure means either that the furnace temperature has to be run lower than ordinary or a process has to be provided for treatment of the spent combustion gases.

A practical design, and actual operation of an air pollution control process was described, wherein an air preheat machine has been employed to reclaim heat from the furnace exhaust gases down to a level of about 350°F., followed by a water scrubbing operation on the exit gases before their exit to an atmosphere at a temperature of about 115°F.

The maximum rate of discharge of particulate and condensible matter from any fuel-fired furnace, including a glass furnace, is now set by law in Los Angeles.

Petroleum Ash and Glass Manufacture

The second paper was "Influence of Petroleum Ash Components on Refractories and Glass" by Minor C. K. Jones, Esso Research and Engineering, Linden, New Jersey. The ash content of petroleum is extremely small and varies from less than 0.001 to about 0.05 per cent of the crude. This ash is nonvolatile and concentrates in residual fractions marketed as heavy fuel oil. A study was made of the reactivity of these residual ash components on the refractories used in industrial furnaces.

Sodium and vanadium were shown to occur in concentrations above 10 per cent in the ash of most crudes and in concentrations of 1.0 to 10 per cent in the ash of the remaining crudes. There were only a few instances where the concentration of vanadium was below 1 per cent. The next most prevalent elements were iron, nickel, aluminum, silicon, and calcium, in that order. Over half the crudes investigated contained traces of copper, magnesium, lead, chromium, and manganese, while a number of other elements such as cobalt, strontium, boron, titanium, potassium, platinum, silver, and molybdenum were present in isolated samples.

These data showed that fuel oils derived from most crudes contain ash which is potentially destructive to refractories. The extent of actual attack in any given furnace will, of course, depend on the concentration of ash in the fuel oil, but in time the ash from most crude sources will damage refractories in furnaces of improper design.

The importance of proper furnace design was emphasized, particularly the selection of refractory brick.

Glass Furnace Regenerators

The third paper was "Comparative Studies of Glass Furnace Regenerators," by Edward P. Vincent, Kaiser Aluminum & Chemical Sales, Inc. This study covered two complete campaigns, the last one being a truly amazing and record-setting performance. The first campaign covered by this report started on March 12, 1951, and ended on March 17, 1953. The second campaign started on April 15, 1953, and continued for 5 years, shutting down for repairs on May 3, 1958.

The furnace is a 4-port cross-fired tank using natural gas and having a stand-by oil firing system. During both campaigns this furnace melted only flint glass. The regenerators are 7¾ feet wide by 32 feet long with the checker height varying from 17.63 feet during the first campaign to 19.1 feet for the second.

TABLE I

General Operating Data

	Mar. '51 to Mar. '53	April '53 to May '58
1. Life in operating days	685	1773.25
2. Total tons of glass melted	79,054	254,036
3. Average tons of glass per operating day	115.4	143.26
4. Total tons of glass per sq. ft. of melting area during campaign.	130.02	375.80
5. Sq. ft. of melting area per T/day	5.27	4.719
6. Melting area in sq. ft.	608	676
7. Average consumption of 1000 B.T.U. Natural Gas per Ton of Glass	7,920	5,979
8. Total checker mass in tons	249	325
9. Flue area perpendicular to flow in sq. ft.	11,400	14,502
10. Cu. ft. of checker volume per sq. ft. of melting area in primary checkers	7.23	7.04

The purpose of the paper was to try to establish some correlation in the performance data, operational changes, and effective changes in the regenerative system. Item 7 of Table I shows a savings of almost 2,000 cubic feet of gas per ton of glass. Assuming the cost of the natural gas to be $0.40 per thousand, the author estimated that the savings would amount to approximately $0.80 per ton or $203,228 during the full five-year campaign.

Factors contributing for, and working against, this fuel savings were many and varied. Item 3 indicates an area that certainly contributed toward the fuel savings. As tonnages increase in a given furnace, the idle load loss is reduced. Here is an increase from 115.4 tons per day to 143.3, or an increase of 24.1 per cent. This increase is also reflected in item 5, substantially reducing the square feet per ton ratio. Item 5 also indicates to some degree the service requirements of the total furnace refractories.

The checker setting used during the period that established the records contained 51 total courses of checkers, 42 of which were basic. The top 5 courses consisted of periclase bricks with a 95 per cent MgO content. Twelve courses below that were bricks made of 92 per cent MgO grain bonded with Volatilized Silica, and basic brick below that were magnesite-chrome type containing approximately 70 per cent MgO. All bricks were chemically bonded.

The basic section contained 83 per cent of the total number of courses; it contributed 295.14 tons or 90.6 per cent to the total mass and accounted for 12,878.14 square feet or 88.9 per cent of the total surface area. These were 13½ x 4½ x 2½ inch unburned basic brick set in an open basketweave style setting. Flue openings were 6 x 6 inches.

The bottom 9 courses were First Quality Fireclay using the 9 x 4½ x 2½ inch bricks in a conventional setting. This section contained 30.38 tons or 9.38 per cent of the total mass and 1,623.99 square feet or 11.1 per cent of the total perpendicular surface area.

The total mass was 325.25 tons or 30.7 per cent greater than the previous setting. The total perpendicular surface area was 14,502 sq. ft. or 27.2 per cent greater than the prior campaign. There were 16 more courses of basic used below the midpoint where the temperatures are considerably lower.

Heat Recovery in Glass Furnaces

The fourth and last paper of the Thursday morning session, "Some Aspects of Heat Recovery in Glass Furnaces," was presented by H. B. Stewart, Toledo Engineering Company, Inc. Recuperative pre-heating of combustion air has been practiced with refractory units for many years with varying degrees of success. Some of the problems encountered, such as excessive leakage, clogging and cracking of the tile, did not provide trouble-free operation.

With the advent of improved heat resisting alloys, metallic recuperators have become very durable and able to withstand severe operating conditions. If they are designed to prevent secondary stresses and to give high coefficients of heat transfer on the air side, long life with little maintenance can be obtained.

A recuperator designed and developed by H. Escher of Australian Iron and Steel Ltd. has overcome many of the difficulties inherent in other recuperator designs.

The recuperator may be applied to furnaces with flue gas temperatures well above the allowable safe working temperature of the metal. This application is possible because the flue gases do not impinge against any section of the heating surface, and radiation from the inlet flue is distributed over a large area by radiation interchange within the cylinder. Single recuperators can handle the waste gas from furnaces utilizing up to 20 mm BTU's of fuel with maximum operating temperatures of 2900°F. Two or more recuperators may be combined for larger furnaces.

The design features and advantages offered by this type of recuperator were summarized as follows:

1) The recuperative continuous firing method overcomes many of the design and operational limitations imposed by regenerative systems.
2) The unit can accept flue gases directly from furnaces operating at temperatures up to 2900°F.
3) The unobstructed flue gas passage offers a minimum resistance to flow and reduces the possibility of carryover buildup.
4) The danger of localized overheating is eliminated because there is no direct impingment of waste gases and because the temperature is equallized by radiation interchange within the cylinder.
5) Optimum overall heat transfer rates are obtained owing to the thin metal wall between the air and flue gases, forced convection by high air velocities, and high radiation from low-velocity flue gases.
6) The design fully accommodates the internal differences in expansion, thus avoiding failure caused by secondary stresses at elevated temperatures.
7) The built-in safeguard against overheating, when the air is interrupted or reduced to a small flow, eliminates the need for elaborate safety devices.
8) The integral construction provides a sealed system for accurate control of the combustion air.
9) The unit, mounted in a vertical position, acts as the furnace stack, and a separate stack is not required.
10) The foundations and building space requirements are minimized by the compact design.

Oxygen Analysis

The Thursday afternoon program was under the chairmanship of R. K. Lang, Ohio Fuel Gas Company. The first paper of that session was "Oxygen Analysis, a Guide to Improving Glass Tank Efficiency," by John Puckett, Leeds and Northrup Company. Combustion control for glass-tank melting is highly desirable in order to provide maximum fuel economy, improved product quality, maximum production rate, proper furnace performance, and best melting conditions. Poor combustion control not only means waste of and improper utilization of fuel but provides inferior glass.

A technique for the continuous measurement of oxygen in furnace gases was described. This method of analysis is based on the paramagnetic properties of oxygen. What is actually measured is the resistance of a wire as a function of temperature.

The analyzer, furnished by Leeds and Northrup, provides for visual recording of the oxygen content, and very high-speed response is possible without the necessity of numerous moving parts. Two sampling probes located on each side of the furnace serve as a means of collecting the gas, and the analyzing equipment is located adjacent to the furnace and collecting equipment.

Provision for cleaning the gas samples is also made, while the provision of a continuous sample for oxygen analysis provides the possibility of further analysis such as CO that may be an additional aid to combustion.

It was emphasized that this data should be correlated with other furnace performance data, as well as the various properties of glass, to be most useful. The use of this versatile equipment offers additional performance data for better control of glass melting.

Interchangeability of Gases

The second paper of the afternoon session was "Interchangeability of Gases" by Rex T. Ellington, Institute of Gas Technology. The problem of fuel gas substitutability has faced the gas industry to some extent throughout this century. During the earlier years the gas was practically all low-BTU manufactured gas, and relatively few types of applications were involved.

Since World War II, the gas industry has committed itself to the task of supplying a significant fraction of all the energy used in the United States. This involves the distribution of tremendous quantities of natural gas or natural gas equivalent, for use in a multitude of applications.

The problem of substitutability is of constant concern to a utility in striving to provide the best possible service to its customers. The change of characteristics of the fuel gas arises from substitution of a different gas for some portions of the fuel.

The air-gas proportioning or mixing systems which are often encountered in the glass industry are the following: *a*) The low-pressure gas or "atmospheric" system; *b*) the high-pressure gas system; *c*) the low-pressure air system; *d*) the mechanical or turbo-premix system; and *e*) the nozzle-mixing system often used for large furnaces.

It was shown that each may react differently to variations in the properties of the fuel gas. The burner systems which they feed react differently to changes in the mixture they utilize. In one case, the result may be to change flame characteristics so that the applications will be adversely affected, and in another it may be to change the chemical composition of the combustion products so that they will have an undesired chemical effect when applied. The problem of fuel substitutability, therefore, really consists of many problems, and the utility merely seeks an overall optimum solution for the operating conditions it encounters.

It can be said that gas utilities are extremely con-

scious of the effects that variation in sendout gas may have on their customers. Where substitutability criteria exist, they are employed by the operating engineer to keep the sendout gas within limits of acceptable performance for all uses. In general, the limits which the domestic atmospheric burner can tolerate are sufficiently narrow so that industrial applications are not adversely affected.

More industrial cases need to be examined in detail, however, to clarify the picture in this area. The manifold applications in the glass industry should permit gathering a wealth of data on fuel gas substitution. Any that can be gathered and analyzed will help the utility to give better service.

Air-Gas Mixing Equipment

The third afternoon paper was "Air-Gas Mixing Equipment," by Arthur Wilcox, Eclipse Fuel Engineering Company. This discussion, primarily limited to various types of gas and air mixers for supplying combustible mixtures to burners of all types, also included some discussion of several types of ratio controls for use where gas and air are not mixed before issuing from the burner nozzle. The general types of air and gas mixers included, basically, the following:

1. Gas jet mixers—also called Injectors, Inspirators, Lo-jectors, Hi-jectors, Venturi Mixers.
2. Air jet mixers—also called LP Proportional Mixers, Aspirators, Variset Mixers.
3. Mechanical mixing machines—also called carburetors, diluters, Consa-Mix, Unimix, Premix units.

The methods of controlling gas and air ratios for combustion included:

1. Separate gas and air valves linked together for controlled operation.
2. Gas-air proportioning arrangements utilizing cross connecting governors.
3. Hydraulic or pneumatic arrangements for controlling the flow of either the gas or air as a function of the other fluid flowing.

Gas jet mixers usually consist of a gas jet directed into the restricted portion of a venturi device to entrain air and deliver the mixture to a piping system. The jet size and the gas pressure available determine the capacity of the unit in BTU/hr., while the relation of throat, discharge tube, and air shutter arrangement determines the amount of air to be entrained and the pressure to be delivered to the system.

Gas may be used at any pressure, but in order to develop a pressure sufficient to drive the mixture through burner or piping of any great resistance, high-pressure gas is required. When using low-pressure gas, such as that ordinarily delivered by utilities, and which can be measured in inches of water, it is customary to entrain only a portion of the total air required for combustion. A formula has been developed which will give an approximate idea of the pressure that can be developed.

Air-jet mixers depend upon the kinetic energy of a jet of air to entrain gas which has been reduced to zero or atmospheric pressure. Reducing the gas pressure to zero permits the equipment to function as a true proportional mixing device because there is no tendency of the gas to flow of its own pressure. The jet of air is fed into a venturi mixing device, creating sufficient suction to draw in the volume of gas required to produce the desired mixture.

Because any variation in back pressure or in burner size causes a variation in the amount of entrainment of gas, it is necessary that the piping system from the mixer to the burner, and the burner size, be kept constant after having once been established. The commonest type of air-gas mixers utilize a fixed throat dimension, meaning that the mixer must be selected for one condition only and is not flexible after installation. During the past several years a number of air-jet mixer variations have been worked out in which a variable air jet and a variable throat opening permit considerable change after installation if the resistance of the burner and piping is more or less than anticipated.

The third type of mixing device utilizes gas at zero pressure and atmospheric air, which, of course, is already at zero pressure, by mechanically drawing them into the inlet of a blower or compressor which compresses the resulting mixture and delivers it to the burner or piping system. Through the use of a governor to reduce the incoming gas pressure to zero, and by arranging a suitable proportioning device, the amount of air and gas drawn into the mixing unit can be maintained at any given ratio, regardless of how much mixture is being delivered to the burner system.

This means that burner of sections of manifold can be turned on and off without affecting the air-gas ratio of other parts of the system. By the use of a constant pressure delivery unit, either blower or compressor, this arrangement permits supplying a constant air-gas mixture to all parts of either a furnace or even a large plant, entirely independent of the operation in any other part of the plant.

The type of air-gas equipment that is to be used for a specific requirement must be selected with consideration given to the entire combustion system. A comparator sheet was used in comparing the various combustion systems. It was pointed out that no one of these systems can claim inherently better efficiency than the rest because no single definition of efficiency can be applied to all of them.

Faster Annealing

The fourth paper of the afternoon session, "Increasing Production of Annealing Lehrs," was given by R. C. LeMay, Selas Corporation of America. The objective, increasing lehr speed and capacity, has been accomplished by what might be called unorthodox methods. Well-controlled, but deliberately non-uniform heat sources have been employed in patterns which match heat losses and have been installed where they could first heat the ware, rather than overheat the conveyor.

By cutting a Duradiant roof section into the top of his lehr near the loading end, a manufacturer running ware with heavy tops and thin bottoms was able to heat the heavier topped ware in its normal position quite rapidly. Ware temperature uniformity was accomplished sooner, and the lehr could be speeded proportionately.

A characteristic of both convection and radiant heat-

ing is to release more heat on sections of ware closest to the source; therefore, by using the two methods to aid each other, in existing lehrs, much can apparently be gained. Advantages of both radiant heating and cooling for lehrs include the following:

a) Radiant heat travels in straight lines; therefore, it can be accurately directed. By contrast, it has always been difficult to direct the course of flowing gases, and, therefore, many of today's lehrs are loaded with dampers and baffles whose purpose is to try to keep convection heat from going where it is not wanted.

b) Radiant burners and radiant cooling panels are easily arranged in desired patterns for use where deliberately non-uniform heat transfer is desired. Such a requirement is found when more heat is needed along lehr edges than in the center, or where heavy ware sections tend to delay desired temperature change.

A radiant-heat roof, whose purpose is to add top heat only, has burner rows piped to common manifolds through which accurately proportioned gas-air mixture is supplied. When it is also desired that the roof provide preferential side heating, valves should be installed between burners and manifolds for heat pattern adjustment, thus requiring gas-air mixture to be supplied from a mechanized mixer, known as a "Combustion Controller."

No other constant-ratio mixing system permits satisfactory operation with valves between burners and mixing apparatus. In addition to permitting valves in mixture lines, this device also supplies a somewhat more precise and uniform gas-air mixture than is found in most lehr combustion equipment today. Radiant heat roofs provide the means for correcting temperature differences and thus permit corresponding production increases. The same principle has been adapted with success to decorating lehrs whose work must be heated from room temperature.

Use of Gas Infra-red in Glass

The last paper of the Thursday afternoon session was "The Use of Gas Infra-red in the Glass Industry," by William R. Van Ittersum, John J. Fannon Products Company. For a great many years, engineers and scientists have known that the most effective form of infra-red heat comes from gas fire. The problem has been to harness it so that it can be directed and controlled for industrial use. A German scientist, Guenther Schwank, finally accomplished this feat. The end result, which is covered by U.S. Patent 2,775,294 and other patents pending, is a ceramic catalyst 2½ inches long, 1¾ inches wide, and ⅜ inches thick. It is perforated with 200 holes to the square inch.

The ceramic tiles are cemented together to form a ceramic mat. This mat is placed in a cast iron housing specially designed and baffled to distribute uniformly the gas-air mixture over the ceramic areas.

The finished product is called a rayhead. Gas is metered through an orifice, passes through an air aspirating chamber to a mixing tube, then to a chamber under the ceramic mat. This is a 100 per cent primary air burner. No pre-mix or blowers are used. The air and gas mixture burns on the surface of the ceramic mat at a temperature of approximately 1650°F. The mat composing the generator has a nominal capacity of 12,000 BTU per hour and is designed to radiate vertically or at an angle.

Infra-red energy must strike an object that will absorb it before heat can be generated. Its behavior thus somewhat resembles light. Bright and smooth objects reflect, and rough and dark objects absorb infra-red. It is sometimes said that infra-red energy penetrates objects. This is not true for opaque material, but for the most transparent or translucent objects, some of the infra-red energy may be transmitted completely through the material. For opaque material, the infra-red absorbed is converted into heat, and the heat is then conducted through the material.

Infra-red energy does not heat air, and therefore requires no intermediate carrier. Its path is in straight lines. It travels with the speed of light and can be directed and reflected in the same manner as light (drafts or wind current cannot bend or divert it). Because it does not heat air, objects are heated directly. It can also be ducted as long as the duct material is a good reflector such as aluminum.

Applications extend to nearly all branches of industry: foundries, ceramic, glass, paint, food, plastic, chemical, metal, paper, textile, lumber, construction, tool and die, and even to transportation and shipping.

Two glass plants in Germany have been very successful in applying this source of heat. The first is a very large manufacturer of lenses. In the grinding and polishing rooms this company has installed the Schwank heaters for humidity and temperature control. By keeping the air and machinery temperature the same and by eliminating convection currents and dust from the air this company has produced higher quality ware.

The second manufacturer makes fine crystal glasses and has built a turntable 9 ft. in diameter with the perfection-Schwank heaters 2½ in. above the top of crystal stemware. The results are said to completely eliminate stress and strain so that the glasses are no longer easily broken.

The glass fiber processor has a great many uses for this type of heat, such as oil burn-off, curing of binders, heating and forming.

Cord Problem in Glasses

The first paper of the Friday morning session was "The Cord Problem in Glasses," by Dr. Leonard G. Gehring, Preston Laboratories, who pointed out that avoiding cordy glass involves the very essence of glass melting and the production of glass articles. It encompasses all parts of factory operation, equipment, and plant practices, up to the forming machine.

It starts with the specifications of the raw materials themselves, and includes the storage, handling, weighing and mixing of the raw materials, and the handling, conveying and feeding of the mixed batch. When the batch is fed into the furnace the problem becomes even more difficult. All details of the furnace design, firing, feeding, temperature, distribution of temperature, glass level and the refractories are important. Furthermore, once the batch is in the furnace one loses sight of what is really

happening, and it is extremely difficult to get into the furnace to find out. All techniques for studying the process are indirect and difficult to apply.

The numerous causes of cords were outlined:

A. The Batch

1. Errors in weighing in the batch house.
2. Inadequate mixing of the batch.
3. Segregation of the batch after mixing.
4. Cullet of the wrong composition.

B. The Melting and the Furnace

5. Silica scum from poor feeding and melting.
6. Segregation in the melt.
7. Stagnant glass.
8. Changes in level, pull, firing, currents, temperature.

C. The Refractories

9. Crown drip.
10. Wash from sidewalls above glass-line.
11. Refractories below glass line (when silica is accompanied with alumina in the cord).

If one cannot spot the cause of the cords by simple tests and observations, then the following four avenues of approach were suggested as an aid to ascertaining the cause:

D. Good Quality Control (Preventive Measure)

1. batch mixing.
2. density and other properties, day-to-day.
3. temperature and firing.
4. pull.

E. Process of Elimination

1. Determination of suitability of batch before introducing it into the furnace.
2. Checking of variations in pull and temperature.

F. Separation and High-Powered Analysis

1. Centrifuge separation according to density (on powder).
2. Analyses to determine composition difference.
   (a) spectroscopic analysis.
   (b) trace elements.

G. Overhauling of the entire glass-making operation to determine necessity of radical changes in equipment and design.

Cord Examination by Immersion Interferometry

The next paper of the Friday morning session was "Examination of Cords by Immersion Interferometry." by Josef Francel, Kimball Glass Company. Definite progress has been achieved in identification of well-defined crystalline "stone" defects, but in the problem of cords, "a more complete understanding of the general aspects of these defects is badly needed so that available information can be used to better advantage." A technique employing multiple beam immersion interferometry was described.

From the point of view of chemical constituents present in the inhomogeneous glassy inclusion, the cords may be divided into the following subgroups:

a) Siliceous.
b) Alkalies.
c) Aluminous.
d) Zirconia.
e) Combinations: silica-alkalies, silica-alumina, silica-zirconia, alumina-zirconia.
f) No chemical change.

The siliceous cords occur very often in soda-lime-silica. borosilicate, and lead silicate glasses. They usually appear as streaks enriched in silica or silica combined with alkalies. The silica-rich layers may be the result of poor batch mixing, separation during melting, volatilization of alkalies, boric oxide and lead oxide from the surface of molten glass, or an attack on silica refractory.

The next step in the identification of the inhomogeneity constituent is the determination of the nature of stress, tensile or compressive. A tensional stress in the zone showing an index increase is associated with soda and lime; a compressive stress in the same zone would indicate presence of alumina or zirconia. Alumina can be further identified by ingenious etching techniques with fluoroboric and hydrochloric acid solution.

The typical interferograms of several common surface defects show the following characteristics.

Silica—Exhibits a rather sharp fringe deflection in the direction of index decrease.

Soda—Broad fringe deflections in the direction of index increase without any sharp boundary.

Lime—The same as soda (tests to differentiate between soda and lime are in progress).

Alumina—Sharp boundary with fringe deflections on the index increase and decrease side. The major portion of the displaced fringe is rather broad and is nearly level over the extent of the displacement.

Zirconia—Extremely sharp boundary at the start and finish of the fringe displacement, which is of the index-increase type.

Silica-Soda—Broad fringes on the index-increase side and rather sharp interruptions with fringe deflection in the direction of index-decreases.

Silica-Alumina—Index decreases are sharp, and increases have alumina type of boundary.

Ream in Flat Glass

The third paper on Friday morning was "Ream in Flat Glass," by Heywood J. Knighton, Ford Motor Company. In an attempt to formulate a general statement for the cause of ream, the following classifications were considered.

1) Raw material quality.
2) Scale errors.
3) Segregation.
4) Incorrect formulation of batch.
5) Changes in furnace operating conditions.
6) Stagnant glass in furnace.
7) Surface tension and/or convection currents.
8) Refractory wash.

Recent tracer tests which were conducted on both plate and sheet glass furnaces at the Ford Motor Company indicated that the homogeneity in a tank is not rapidly attained. The plate glass furnace was producing glass at the rate of 192 tons per day at a ratio of 5.65 sq. ft. of melting area per ton of glass per day. The tracer material was mixed with the batch and introduced into the furnace for a one-hour period. It first appeared in the ribbon 5 hours after its entry into the furnace, and even after 48 hours was still very much evident in the glass as "non-homogeneous layers."

The sheet glass furnace was producing glass at a rate of 130 tons per day at a ratio of 12.7 sq. ft. of melting area per ton of glass when a similar test was conducted. The tracer was introduced into the furnace

(*Continued on page* 47)

Transaction Completed:

L. O. F. GLASS FIBERS SOLD TO J-M

The assets and business of L. O. F. Glass Fibers Company will be sold to Johns-Manville Corporation on the basis of one share of J-M common stock for each 2½ shares of L. O. F. Glass Fiber common stock. Shareholders of the latter firm voted approval of this transaction at a special meeting on December 12, 1958.

Libbey-Owens-Ford Glass Company holds about 50 per cent of the 2,710,193 shares outstanding on the record date of November 14.

The business, properties and assets of L. O. F. Glass Fibers will actually be sold to "Johns-Manville Fiber Glass Inc." which will be incorporated in Delaware as a wholly owned subsidiary of Johns-Manville Corporation. This will become the tenth operating division of Johns-Manville. Closing of the transaction took place in late December, according to G. P. MacNichol, Jr., chairman, and R. H. Barnard, president of L. O. F. Glass Fibers.

The company reported net sales of $23.3 million in 1957 and net income of $1.1 million, or 41 cents a share, with total assets of $27.5 million. In the first nine months of 1958, earnings rose to $1,142,558, or 42 cents per share, compared with $951,100 (35 cents a share) for the first nine months in 1957.

L. O. F. Glass Fibers Company was established in November, 1954, to acquire the net assets and business of the Fiber Glass and Corrulux divisions of Libbey-Owens-Ford Glass Co. It merged in March, 1955, with Glass Fibers, Inc., which in turn had been formed in 1944 by R. H. Barnard, based on his development of the Barnard process of electronic-extrusion for making glass fibers.

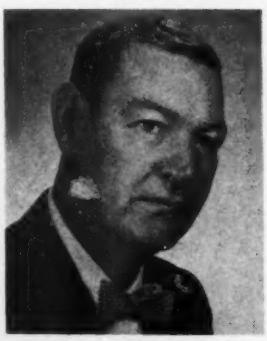
The company employs 1,658 persons and has seven plants, one each in Waterville, Ohio; Parkersburg, West Virginia; Houston, Texas; and Corona, California; and three in Defiance, Ohio.

NAMED RESEARCH MGR. BY AMER. POTASH

Dr. David R. Stern has become manager of research at the Los Angeles plant of American Potash & Chemical Corporation, succeeding Harold Mazza who recently became plant manager.

Mr. Stern had previously been assistant manager of the parent company's main research laboratory at Whittier, California.

HOMMEL NAMES SPERBER



Robert E. Sperber

Robert E. Sperber has been appointed assistant to the president of the O. Hommel Company. Mr. Sperber will be active in the expansion and promotion of the company's activities in all phases of the ceramic industry. He will be working closely with the frit division and will be in close contact with Hommel's sales and service representatives.

WARD, V.P., CORNING FOUNDATION

John B. Ward has been elected vice president of the Corning Glass Works Foundation and has been succeeded by Forrest E. Behm, as general manager of the New Products Division.

With Corning since 1943, Mr. Ward became sales manager of that division in 1956 and general manager

J. B. Ward

F. E. Behm

the following year. Mr. Behm joined Corning in 1946. In 1955, he became manager of Television Bulb Sales.

Other appointments include: Oakes Ames manager of the Albion, Michigan plant; David E. Leibson, manager of the Greenville, Ohio, plant; and Robert B. Lukingbeal, production superintendent of the Greenville plant.

TOLEDO AWARD PROGRAM

The 1959 Toledo Glass and Ceramic Award will be presented at a dinner at the Toledo Club of the Northwestern Ohio section of the American Ceramic Society, on Monday, January 19. Headquarters for the day's sessions will be the Hillcrest Hotel. A program expected to attract glass technologists from many parts of the country has been arranged under the direction of Dr. Archie N. Solberg, University of Toledo.

Dr. Fred Bishop, technical assistant to the technical director of the Kimball division of Owens-Illinois Glass Co., will be moderator of the afternoon session at the University of Toledo on "The Future of Refractories for Glass Tanks." Speakers at this symposium will be Oscar G. Burch, Owens-Illinois Glass Company; Beuther L. Schmidt, Anchor Hocking Glass Corporation; A. C. Siefert, Owens-Corning Fiberglas Corp.; J. S. Gregorius, Pittsburgh Plate Glass Co.; Wilson R. Barnes, Corhart Refractories Co.; Karl H. Sandmeyer, Carborundum Company; Everett A. Thomas, the Chas. Taylor Sons Company; and Raymond E. Birch, Harbison-Walker Refactories Company. The morning will be devoted to meetings of technical groups, and plant visits.

The award this year will be presented to Dr. Games Slayter, vice president in charge of research and development of Owens-Corning Fiberglas Corp.

MOISTURE PROOF CAPACITATOR

Corning Glass Works has developed a new, moisture-proof glass capacitator, with superior shock and vibration resistance. Designed for advanced missile and radar systems, the condenser has passed tests subjecting it to more than 40 days under high humidity.

Inventions and Inventors

Annealing and Tempering

Glassware cooling and transferring apparatus. Patent No. 2,833,088. Filed August 31, 1954. Issued May 6, 1958. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Ralph H. Olson and Keith Conrad.

This invention relates to apparatus for handling glassware, and particularly to an apparatus for cooling and transferring glassware upon its removal from a forming machine.

The apparatus includes a nozzle arm for cooling the internal surface of the glass article. The nozzle arm is mounted on a shaft provided for limited relative movement in the base. The shaft is connected to a sleeve which in turn is reciprocable within a hollow housing, forming a part of the cross head. A spring normally urges the shaft upwardly relative to the base. When the crosshead moves downwardly, the lip on the housing contacts the flange on the lower end of the sleeve and holds the shaft and in turn moves the cooling nozzle arm downwardly. A limited relative movement is provided between the crosshead and the shaft before the lip contacts the flange.

Basically, the apparatus comprises an article support which is vertically reciprocal and has means formed therein for cooling the exterior surfaces of the glass article. The apparatus further includes means for cooling the internal surfaces of the glass article as it is moved vertically, said means moving with the support for a portion of its vertical travel.

There were 5 claims and 11 references cited in this patent.

Feeding and Forming

Forming glass molding tools. Patent No. 2,820,375. Filed December 22, 1954. Issued January 21, 1958. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Paul W. Brower.

This invention relates to the forming of molding tools for use in the molding of molten glass or other materials which, under high temperature molding conditions, subject the forming tools to highly abrasive or detrimental action. Various types of shaping and forming tools may be made, for example, a neck mold, parison mold, a blowing mold, or a forming or shaping plunger.

In the normal procedure in this invention, the tubular section is compressed slightly, then sand blasted on its inner surface contours. Following the sand blasting, hard cutting material, such as the well known Colmonoy or other chrome, nickel, boride coatings is flame sprayed on this internal surface area and then the sprayed form is subjected to a temperature sufficiently high to fuse the surface coating material and the base member together.

Thereafter, these semi-circular members are held in aligned relationship to form a complete circle and the desired molding contour will be ground or formed into the coating material. Thus, a split mold type of finish may be readily formed and, of course, if a solid single piece finish is desired the annular members need not be parted or segregated into these mentioned halves.

The coatings may be applied by the ordinary flame spraying process, followed by the fusion of this flame sprayed material to the base material either by the application of a flame torch, a furnace, induction heating or such other means as might fuse the two materials together.

There were 7 claims and the following references cited in this patent.

United States Patents

1,864,590, Fiefield, June 28, 1932; 2,258,894, Janco, Oct. 14, 1941; 2,361,962, Ronay, Nov. 7, 1944; 2,423,857, Talmage, July 15, 1947; 2,494,970, Shea, Jan. 17, 1950; 2,588,422, Shepard, Mar. 11, 1952; and 2,626,221, Elliott, Jan. 20, 1953.

Furnaces

Glass melting furnace. Patent No. 2,834,157. Filed November 3, 1954. Issued May 13, 1958. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Urban E. Bowes.

The furnace embodying this invention essentially comprises an inverted frusto-conical hearth portion and a cooperating dome-shaped cover.

At spaced intervals around the periphery of crown, scraper blades are vertically mounted. As the hearth is rotated, the scraper blades function to maintain a minimum thickness of batch on the top portion of the hearth, scraping the excess batch over the edge into the frusto-conical interior of the furnace.

With the interior surface of the furnace defined by the contiguous convolutions of metal tubes, a highly viscous layer of glass is retained in contact with such tubes and, in effect, operates as an effective refractory to protect the actual walls of the furnace from the corrosive effects of the melting chamber. The high heat transfer characteristics of the contiguous convolutions of the metal tubes, plus fluid coolant, effectively prevent the establishment of localized hot spots, so that the layer of actual refractory is effectively protected against any extreme localized heat. At the same time, the layer of highly viscous glass effectively protects the metal tubes from the corrosive effects of the flames and less viscous glass. Thus, the amount of heat transferred to the metal tubes is minimized, and a greater percentage of the heat generated within the furnace is retained in the fusing mass. A depending flange in cooperation with an annular channel of sand effectively retains the flames and combustion products within the interior of the furnace.

Since the maximum amount of heat required in a glass making operation is utilized in the melting step, a furnace embodying this invention will permit large-quantity production of glass with less fuel than has heretofore been possible. (*Continued on page* 44)

Detection of Reaction Products Between Water and Soda-Lime-Silica Glass

• THE REACTION BETWEEN glass and water is affected by several factors—the composition of the glass, the ratio of glass surface area to volume of water, and the temperature, pressure, and time duration of the reaction. The course of the reaction is affected further by the accumulating reaction products. To study these effects, the reaction products must first be identified.

Wang and Tooley in the November, 1958, issue of the Journal of the American Ceramic Society describe an approach to the problem in which a simulated extract is used to identify the reaction products, i.e., the constituents of glass extracts.

A simulated extract was prepared to approximate the exact composition of the glass extract by dissolving specified substances of definite quantities in water. When this simulated extract gave the same reaction rate on the fresh glass surfaces as that of the glass extract, it was concluded that the latter had the same constituents as the simulated extract and that the reaction products between glass and water were identical to the substances that were used in preparing the simulated extract.

The composition, on a weight basis, of the glass used in this study was SiO_2, 74 per cent; Na_2O, 14 per cent; and CaO, 12 percent. The procedures adopted for the preparation and exposure of the glass samples for the reactions were the same as The American Ceramic Society Tentative Method No. 1.

A fresh glass sample was used for each reaction. Ten-gram glass samples, after digestion in 50 ml. of attacking solution at 90° 0.5° C. for a definite period of time, were filtered through a screen. The sodium, calcium, and silicon contents of these extracts were determined quantitatively.

The amount of sodium in the glass extracts was determined by the flame photometric method. The direct intensity method was the only method employed. A flame photometer of the Perkin-Elmer model 52-C with an acetylene burner was used.

The volumetric determination of calcium in solutions, using Versenate as a chelating agent, was adopted. Modifications were made to the method described by Cheng and Bray. Calcium was determined by using a standard magnesium solution to titrate the test solution, where excess Versenate solution was added. The dye Erichrome Black-T was used as an indicator, and the end point occurred when the color of the solution changed from blue to wine red.

The silicon content was colorimetrically determined by the molybdenum blue method. Light transmittances of the solutions were measured by a Lumetron photometer with a 650 filter. Beer's law was applied.

In this study, the accuracy of the sodium determination was of the order of 0.02 mg. per 50 ml. of solution; of the silicon, 0.02 mg. per 50 ml. of solution; and of the calcium, 0.1 mg. per 50 ml. of solution.

Examination of the data obtained brought out the following points:

(1) The glass extracts reacted with the glass at a different rate than did water.

(2) The glass extracts, containing the same proportions of sodium, silicon, and calcium, reacted with the glass with the same reaction rate.

(3) Solutions of the same chemical composition, but of different constitutions, reacted with the glass with varied reaction rates.

(4) A solution (simulated extract A_1) was synthesized to approximate very nearly the glass extract (glass extract A) in the rate of reaction with the glass.

(5) The products of the reaction between the glass and water were found to be sodium metasilicate, calcium metasilicate, and metasilicic acid.

A distinction was drawn between the chemical constitution and the chemical composition of a solution. A given solution was found by chemical analysis to contain definite amounts of sodium ions, calcium ions, and silicate ions. These quantities represented the chemical composition of the solution. The constituents from which these ions originated represented the constitution of the solution. In other words, reaction products represent the chemical constitution, and ions of the reaction products represent the chemical composition of the glass extract.

The results indicate that the reaction rates for the glass and water were different from the reaction rates for the glass and glass extracts. It shows the expected results: that ions extracted from the glass affected the course of the reaction between the glass and water.

Composition of Glass Extract A

Sodium:	0.35 mg. per 50 ml. of solution
Silicon:	0.30 mg. per 50 ml. of solution
Calcium:	0.08 mg. per 50 ml. of solution

Composition of Glass Extract B

Sodium:	0.60 mg. per 50 ml. of solution
Silicon:	0.52 mg. per 50 ml. of solution
Calcium:	0.14 mg. per 50 ml. of solution

Glass extracts A and B* reacted with the glass with the same reaction rate. These two extracts had the same proportions of sodium, silicon, and calcium but different total amounts. The fact that identical rates resulted from the reactions of glass extracts A and B on the glass suggested that in very dilute solutions the ratios of the constituents played greater roles in affecting the reaction than did the mere quantities of the constituents.

Simulated extracts† A_1, A_2, and A_3 represented solu-

*Glass extracts A and B were obtained from the reactions between the glass and water at 90°C. at different reaction periods. The amounts of glass and water used in each were different. Glass extracts A and B were found to have the same proportions and different amounts of sodium, silicon, and calcium.

† Simulated extract A_1 was prepared from sodium metasilicate, metasilicic acid, and calcium metasilicate. Its composition was the same as that of glass extract A.
Simulated extract A_2 was prepared from sodium hydroxide, metasilicic acid, and calcium hydroxide. Its composition was the same as that of glass extract A.
Simulated extract A_3 was prepared from sodium metasilicate, sodium hydroxide, metasilicic acid, and calcium metasilicate. Its composition was the same as that of glass extract A.

tions of the same composition but of different constitution. Their different rates of reaction with the glass indicate that the constitution was more influential than was the composition of the reactant solution on the course of the reaction. It was also indicated that simulated extract A_1 approximated very nearly glass extract A in its rate of reaction with the glass.

By the logic that different constitutions gave different reaction rates, such as in the case of simulated extracts A_2, and A_3 and A, it was reasoned that a solution having the same composition as a given extract and giving a similar reaction rate could be interpreted as approximating the same constitution as that of the extract. Glass extract A therefore was considered to approximate most closely the constitution of simulated extract A_1 rather than the constitution of either A_2 or A_3.

It was concluded that the reaction products from glass and water were sodium metasilicate, calcium metasilicate, and metasilicic acid because simulated extracts made from these constituents paralleled most closely the rate curves obtained with the actual extracts.

Although hydroxyl ions were found in the sodium metasilicate solution, sodium hydroxide was considered as an intermediate, rather than a major, reaction product.

As the reaction between the glass and water proceeds, the identities of the reaction products may change. Their identities could be detected, however, by a study similar to that outlined in this paper. This type of study conceivably could be extended to glasses of varied compositions and attacking agents of all kinds.

H. A. P. PIJNACKER

H.A.P. Pijnacker, president of N. V. Vereenigde Glasfabrieken, N.V. Koninklijke Nederlandsche Glasfabriek, N. V. Van Deventer's Glasfabrieken, and N.V. Nieuw-Buiner Glasfabrieken, passed away on November 25, 1958. He was 66 years old. Mr. Pijnacker was internationally known in the glass technology and manufacturing fields.

H. K. PORTER APPOINTS STEWART

Wilfred H. Stewart has joined the H. K. Porter Company, Inc., as manager of engineering services, Refractories Division, and will be located in Pittsburgh.

MINNESOTA MINING ELECTS BARNES

Dr. Carl E. Barnes has been elected vice president for research of the Minnesota Mining & Manufacturing Company, with responsibility for all major research programs and policies. Dr. John W. Copenhaver will take over the post of director of central research which formerly had been filled by Dr. Barnes.

CORNING NAMES LAWRIE FOR SIDNEY PLANT

John A. N. Lawrie has been named production superintendent of the new branch plant of Corning Glass Works being built near Sidney, Australia. Mr. Lawrie, a native Australian, is spending several months at Corning headquarters for training. The new plant will manufacture television bulbs and is expected to be in operation by Spring.

FIFTH INTERNATIONAL CONGRESS ON GLASS

The Fifth International Congress on Glass will be held this year in Munich from June 29 to July 4. The technical sessions will cover control techniques for production efficiency; furnace instrumentation; refractories; transmission of infra-red radiation through glass; and the strength of glass, in addition to miscellaneous subjects.

The refractories session will include new developments in refractory materials and experimental methods of evaluating the suitability of the refractories for use in the glass industry.

The historical and artistic sessions will cover the history of the technique of glass, and the art of glass in the Roman era; the history of the art of glass during the middle ages; and industrial design of glass.

The text of the papers will be printed prior to the Congress and will be distributed among the delegates so as to leave maximum time for discussions during the technical session.

LEEDS AND NORTHRUP NAMES THREE

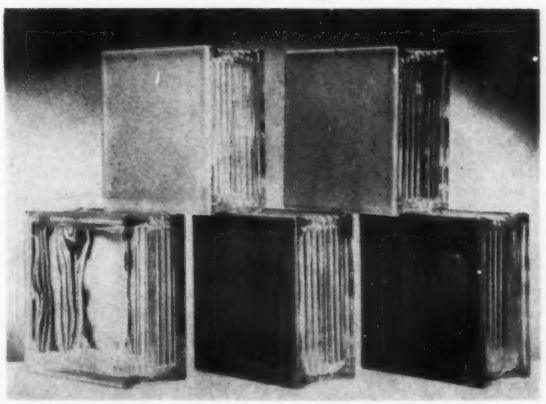
Leeds and Northrup of Philadelphia, has created three new vice presidencies in line with broad top-level revisions in management of the company. Nathan Cohn, former manager of the market development division, was named vice president for technical affairs, and will supervise the research and development department, the engineering department and the patent division.

Raymond C. Machler, director of research and development, G. Lupton Broomell director of engineering, and J. Clarence Peters, manager of the patent division, will continue in these posts.

Donald E. Moat, present director of marketing, was named vice president for marketing, and John F. Quereau, vice president for manufacturing. Each will retain his former supervisory capacities.

CERAMIC FINISH ON GLASS BLOCK

Kimble Glass Company has announced a new method of firing a colored ceramic finish on a glass block at a very high temperature, causing the color to fuse with the face of the block. It is similar to the method used in firing ceramic colors on soft-drink bottles. The color does not chip and is said to be weather resistant.



Kimble Glass Company's insulating glass block with colored ceramic finish. High-temperature process makes color permanent, and weather resistant.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during October, 1958, was as follows: *Flat Glass:* a preliminary figure of 11,000 given for October, 1958, indicates a decrease of 60.7 per cent under the adjusted 28,000 reported for September, 1958. *Glass and Glassware, Pressed and Blown:* a decrease of 1.1 per cent is shown by the preliminary figure of 83,000 reported for October, 1958, when compared with the adjusted figure of 83.9 recorded for September, 1958. *Glass Products Made of Purchased Glass:* the preliminary figure of 14,300 given for October, 1958, indicates an increase of 4.4 per cent over the previous month's adjusted figure of 13,700.

Payrolls in the glass industry during October, 1958, were as follows: *Flat Glass:* a decrease of 97.6 per cent is shown in the preliminary $363,096.73 given for October, 1958, when compared with September's adjusted $15,643,516.56. *Glass and Glassware, Pressed and Blown:* an increase of 0.9 per cent is shown in the preliminary $31,529,551.13 reported for October, 1958, when compared with the previous month's adjusted $31,253,422.04. *Glass Products Made of Purchased Glass:* a preliminary figure of $4,640,326.69 was reported for October, 1958. This is an increase of 3.3 per cent when compared with the adjusted figure of $4,493,710.97 for September, 1958.

GLASS CONTAINER SHIPMENTS
(All Figures in Gross)

Narrow Neck Containers

	November, 1958
Food	927,000
Medicinal and Health Supplies	1,396,000
Chemical, Household and Industrial	754,000
Toiletries and Cosmetics	792,000
Beverage, Returnable	505,000
Beverage, Non-Returnable	88,000
Beer, Returnable	41,000
Beer, Non-Returnable	598,000
Liquor	937,000
Wine	380,000
Sub-total (Narrow)	6,418,000

Wide Mouth Containers

Food	*927,000
Medicinal and Health Supplies	370,000
Chemical, Household and Industrial	135,000
Toiletries and Cosmetics	256,000
Packers' Tumblers	24,000
Dairy Products	159,000
Sub-total (Wide)	*4,144,000
Total Domestic	10,562,000
Export Shipments	289,000
TOTAL SHIPMENTS	*10,851,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY
(All Figures in Gross)

		Production Nov., 1958	Stocks Nov., 1958
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,124,000	6,746,000
	Wide Mouth	*4,363,000	*6,176,000
Beverage, Returnable		577,000	1,825,000
Beverage, Non-Returnable		94,000	231,000
Beer, Returnable		134,000	471,000
Beer, Non-Returnable		650,000	951,000
Liquor		940,000	1,408,000
Wine		432,000	780,000
Packers' Tumblers		28,000	125,000
Dairy Products		191,000	255,000
TOTAL		*11,533,000	*18,968,000

* This figure includes Fruit Jars and Jelly Glasses.

Glass container production: production based on figures released by the Bureau of the Census, Industry Division, was 11,533,000 gross during November, 1958. This is a decrease of 13.3 per cent under the previous month's revised production figure, 13,299,000 gross. During November, 1957, glass container production was 11,457,000 gross, or 0.65 per cent under the November, 1958, figure. At the end of the first 11 months of 1958, glass container manufacturers have produced a preliminary total of 134,502,000 gross. This is 1.6 per cent below the 136,745,000 gross produced during the same period in 1957.

Shipments of glass containers during November, 1958, came to 10,851,000 gross, a decrease of 16.9 per cent from October, 1958, shipments which totaled 13,072,000 gross (revised). Shipments during November, 1957, amounted to 12,293,000 gross, or 13.3 per cent over November, 1958.

At the end of the first eleven months of 1958, shipments have reached a preliminary total of 134,502,000 gross, which is 1.6 per cent below the 136,745 gross shipped during the same period of the previous year.

Stocks on hand at the end of November, 1958, came to 18,968,000 gross. This is 4.2 per cent over the 18,203,000 gross on hand at the end of October, 1958, and 14.4 per cent higher than the 16,580,000 gross on hand at the end of November, 1957.

MEXICO REFRACTORIES PROMOTES MADDOX

J. Paul Maddox has been named manager of market and research development of Mexico Refractories Company, Mexico, Missouri.

CORNING OPENS ELECTRONICS PLANT

The Corning Glass Works has begun production in a new, 142,000-square-foot plant in Bradford, Pa., where the company will manufacture glass electronic components. This plant will produce glass resistors, capacitors and other parts for uses ranging from guided missiles to radio and television sets. Most of the components will be of miniature and sub-miniature types.

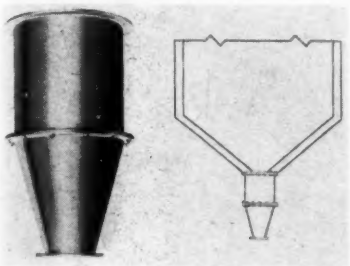
New Equipment and Supplies

FLAT FLAME FOR FURNACES

The North American Mfg. Co., 4455 East 71st St., Cleveland, has developed a tile burner which throws a flat flame (without forward velocity or local hot spots) perpendicular to the burner centerline. This gas burner has no inpingement baffles and no metal parts exposed to excessive heat. Designed for glass annealing furnaces, forehearths, and other installations where heat must be uniform over a large area, and close to the work, the burner is offered in six sizes.

BIN DISCHARGER

Fairmont Machinery Company, Fairmont, West Virginia, has developed a device to regulate the outflow of bulk solids by gravity at speeds up to 7000



lbs. per minute, while preventing ratholing, arching and funneling. A stainless steel double-cone element maintains the material in an unpacked state once it enters the discharger.

CONTINUOUS BLENDER

The Johnson-March Corp., Philadelphia, has a continuous-flow blender which proportions, mixes, blends and discharges dry materials, or blends liquids with solids in precise quantities. Called *Verticone*, applications in glass and ceramic industries include mixing of sands, clays, pigments and other raw materials, treating them so as to reduce dust during handling.

Blending is done by feeding dry elements onto apex of a cone. As materials leave base in continuous curtain, controlled wetting is achieved by spraying with smaller quantities of moisture. All high wear points have replaceable parts and wear plates. Winterized equipment is available for exposed operation.

WEATHERPROOF UTILITY BLOWER

Robinson Ventilating Co. of Zelienople, Pa., is now manufacturing a weather-tight utility blower with motor and mechanism protected by a steel en-

closure, permitting use of an economical open-type motor. The heavy-gauge steel unit can be supplied in sizes for volumes of 150 to 16,000 c.f.m. and in fan blade sizes from 12″ to 27″.

BLENDER

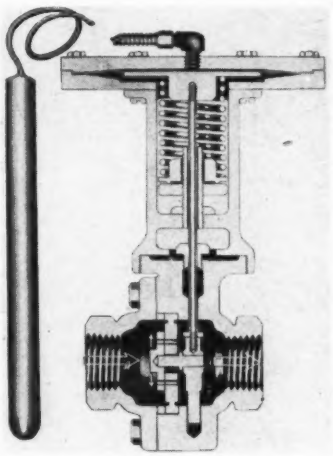
Colonial Iron Works Company, Cleveland, Ohio, has developed a new blender which combines solid particles in a vertical conical shell, mounted apex-down. A central rotating shaft inside the shell carries blades aligned so as to induce solids circulation patterns. Air or gas is admitted at the apex of the cone at a rate sufficient to induce fluidation of the blend in the apex region.

The air current and the blades com-

bine to flow the solids up the center of the cone, overspill at the top and descend along the wall back to the apex in a continuous circulation movement. Performance test material and reports available from the company.

VERNIER VALVE

OPW-Jordan Corp., Cincinnati, Ohio, has announced new 4″ and 6″ valve systems for controlling flow of fluids or steam by remote sensing of temperature variations. The systems can handle 50,000 lbs. per hour of steam or 2300 gallons of water per minute, at temperatures from 35° to 450°F, with pressures up to 125 psi. Designed primarily for controlling temperature of tanks, compressors, etc., by controlling flow of heating or cooling fluid, the valve features a patented sliding gate shut-off of stainless steel, which cannot blow through or overheat. Accurate modulation of valve movement is said



to give unusual control of flow in minute gradients.

MONITOR

The Foxboro Co., Foxboro, Mass., has a monitor which automatically scans several hundred process measurements at speeds of 5 points per second, giving visible and audible warning when "alarm" condition is noted. The device operates by comparing voltage indicated by a thermocouple or other measuring element with a reference voltage present for each operation to be monitored.

Scan rate can be varied; operation

can be automatic or manual; alarm light resets automatically when operator acknowledges alarm to machine, and measurement returns to normal.

MORE EFFICIENT BLOWERS

Joy Manufacturing Co., Pittsburgh, Pa., has a new line of centrifugal blowers featuring airfoil-shaped fan blades and a wide range of pressures and volumes for specific air movement applications. Sizes vary from 440 cfm at ¼″ static pressure for a single-width, single-inlet fan to more than 460,000 cfm at 16″ static pressure for a double-width, double-inlet fan.

CATALOGUES RECEIVED

Link-Belt Co., Prudential Plaza, Chicago, Ill. has published a 24-page book devoted to the company's Flexmount, Coilmount and Torqmount conveyors. The conveyors are designed to handle capacities from 25 t.p.h. to 350 t.p.h.

Sutorbilt Corp., Compton, California offers a blower bulletin discussing air and gas handling problems. The fully illustrated eight-page booklet shows a wide variety of Sutorbilt applications. Included are details of the basic Sutorbilt blower.

Walsh Refractories Corp., 101 Ferry St., St. Louis 7, Mo., has released a six-page brochure in Spanish, describing the company's complete line, and stressing the facilities of the company's export division. Tables of temperature limits and other technical data are provided, with a chart of standard shapes available in the company's products.

The Hayes Corporation, Michigan City, Indiana, has published a 19-page bulletin on draft as it affects the efficiency of the combustion process. Sections in the booklet show where and how to measure draft and pressure in modern plants, and where and how to install draft gages.

Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa., describes its new insulating and refractory foamed silica material, Foamsil, in a new folder. The material is 99 per cent pure fused silica and has a practical operating range of –450° to 2200°F. It is not altered by most commonly used acids, or by thermal shock.

Kybernetes division, Hagan Chemicals and Controls, Inc., Pittsburgh 30 Pa., has published a bulletin describing the company's electronic temperature indicator. The bulletin covers operational features of the monitor, which scans up to five thermocouple inputs per second, compares their readings with preset safety limits, and actuates audio-visual signals when limits are violated.

Clark Bros. Co., Olean, N. Y., has published a bulletin detailing operating experience with the Mark TA 750/1000 kw gas turbine.

Selas Corporation of America, Dresher, Pa., has a 4-page bulletin, "Selas Hand Torches," illustrating a new line of gas-fired, spear flame hand torches for glass ampoule sealing, laboratory works, glass working and preheating, among other uses.

RALPH DAY BECOMES GLASS CONSULTANT

Dr. Ralph K. Day, for many years associated with the glass industry, has announced his availability as a consultant on matters pertaining to research, glass tempering processes and quality measurement and control. He will be located at 307 West Harrison Avenue, Maumee, Ohio.

He was most recently associated with Libby-Owens-Ford Glass Co. (1944-1958) in research and development and was closely associated with furnace operation and observations; sheet glass quality control; and basic research in glass polishing.

Dr. Day has written a book, "Glass Research Methods," and has had a number of papers published on various glass manufacturing processes. He has also been granted several patents in glass technology.

50TH ANNIVERSARY FOR SILVERMANS

Dr. and Mrs. Alexander Silverman celebrated their 50th wedding anniversary at a family dinner on December 16 in Pittsburgh. Dr. Silverman is professor and head, emeritus, of the Chemistry Department in the University of Pittsburgh, and an international authority on glass.

RUTGERS PROBES GLASS FOR MILITARY

Rutgers University School of Ceramics is conducting special studies under the direction of Prof. C. J. Phillips to find new ways of tailoring glass and ceramic materials to fill the broad requirements in handling strength and stability in wide temperature variations.

GELLER TO RECEIVE BLEININGER AWARD

Rome F. Geller will receive the 1959 Albert Victor Bleininger Award, the highest honor in the field of ceramics. It is presented each year at a dinner by the Pittsburgh Section of the American Ceramic Society.

Mr. Geller served as chief of the Porcelain and Pottery Section of the National Bureau of Standards, from which he retired in 1956. He still serves the NBS Mineral Products Division, however, as chairman of its editorial committee and as a ceramic consultant. Mr. Geller has 65 published papers in the fields of refractories and whitewares, as well as a patent for a thoria resistor heating element.

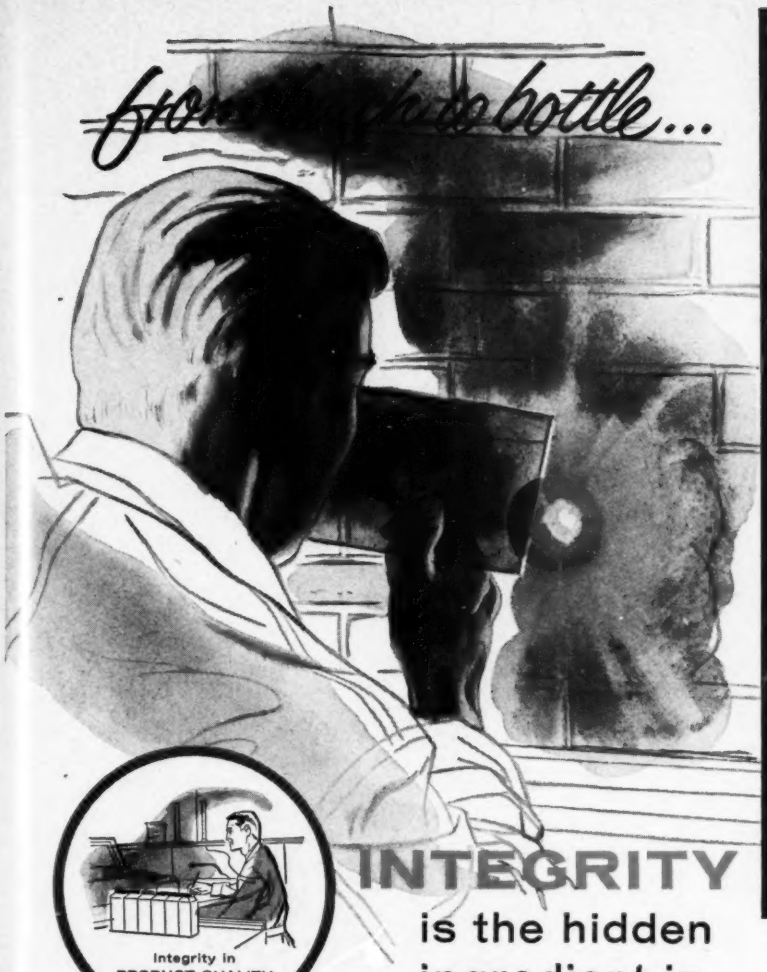
The Award will be presented at a Dinner on March 13, at the Pittsburgh Athletic Association.

DeMARIA FORMS NEW COMPANY

Glass Products Development Laboratory, 204 Sunrise Highway, Massapequa Park, N. Y., has been established by Vincent C. DeMaria as a glass fabrication service. The company will offer a consulting service for the development and manufacture of scientific glass apparatus, electronic glassware and conductive coatings on glass.

Modern glass-blowing facilities are also available for special apparatus work to meet customer specifications.

Mr. DeMaria has had 16 years of experience with Sylvania Electric; C. B. S. Laboratories; Western Electric Co.; and the glass division of Fisher Scientific Co., of which he was manager. He points out that the purpose of the new company is to devise new glass products and improved techniques through sponsored development.



INTEGRITY
is the hidden ingredient in
Trona® SODA ASH

There's an important ingredient in Trona SODA ASH that's hidden to the eye, does not show up in laboratory analyses or photomicrographs. Yet, from batch to bottle, this ingredient—the *integrity* of Trona Soda Ash—is vital to the glassmaker's art. Trona integrity works for you three ways. Our constant striving for superior quality contributes to the continued improvement of your own end-products. Our Sales and Production departments work as a team to make delivery *when* you want it and *how* you want it. Our glass technology section provides you with specialized technical service on a confidential basis to help you cut costs and improve your process to meet today's changing market. You'll benefit through the integrity inherent in Trona Soda Ash and Trona service. We'll be glad to show you how.

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and other diversified chemicals for Industry and Agriculture

(*Continued from page* 20)

taken over several seasons, operating costs are computed to average $10.71 per month.

The Comfort-Conditioned Home Program reflects confidence in the future growth of the glass fiber industry. About 41 per cent of glass fiber sales are of materials that go into the home, either directly or as components in the products of customers.

Draperies of Fiberglas Aerocor

Fiberglas drapery fabrics are being offered in two weaves utilizing new Aerocor texturized yarn: Velvet Glass, which imparts a silk mohair-like *hand*, and Flaxen Glass, which has the look and *hand* of linen.

Improved Polyethylene Film

Polyethylene film, reinforced with glass fibers, has been introduced under the brand name of "FRF." This fiber glass reinforced polyethylene film provides greater strengths with thinner materials, eliminates stretching, bagging, and billowing.

One of the chief advantages of the new, improved FRF product is an increased re-use value for film owing to its improved strength and tear resistance. FRF is more easily handled because of the "body" or its flexible stiffness. All qualities of polyethylene film—an efficient moisture and dust barrier and quick heat sealing—are retained in the new FRF. Among the more common uses of the reinforced film are weather, moisture and dust barriers for construction; temporary silos, haystack covers and equipment protection for farmers; lightweight, low-cost bulk packaging for foods and chemicals; and outdoor warehousing and machinery protection for industry.

New Fiber Glass Filter

A new fiber glass air filter utilizing die-cut, chipboard grille-work, rather than metal stampings, has been developed by the fiber glass division of Pittsburgh Plate Glass Company. To be known as the Glasfloss Safety-Grille filter, the new product is said to be particularly desirable for industrial applications because of its safety advantage in the elimination of metal grille-work in its design preventing hand and wrist cuts from broken metal.

V—TECHNICAL GLASS

Sales of all major lines, except television, were excellent during 1958. Earnings in general were adversely affected by rising labor costs, materials, and supplies. The sales of a major producer in this field in 1957 was approximately $159 million, and production in 1958 is likely to be equal to or greater than this amount.

Pyroceram

The most significant new development in the field of technical glass has been the progress in the use of Pyroceram, a new family of glass-ceramic materials announced last year by the Corning Glass Works. The company reports that over 8,000 inquiries concerning possible uses have been received since that time.

A new name in housewares—Corning Ware—appeared on the market during 1958 when the company placed on sale its new line of Pyroceram cooking utensils. Consisting of a 10-inch all-purpose dish and three saucepans, they were introduced to the public first in the New England area on a mass market testing basis, and later in the New York and Philadelphia markets, and finally the West Coast. Corning expects to be in national distribution by 1959.

Each piece of the new line is white, with a blue flower pattern that is a part of the material and will not scratch or burn off. The dishes have the look and feel of fine china; yet they can be taken red hot from a stove top and plunged into ice water without cracking or crazing.

Pyroceram is essentially a material that has been converted into a crystalline ceramic from its original glassy state by heat treatment. Certain nucleating agents are added to the glass batch, which is then melted, formed, and cooled. When the glass is reheated at temperatures which permit crystallization, billions of invisible crystallites are formed throughout the glass body. Each crystallite acts as a center for crystal growth as the heat continues. Composition of the glass and heat treatment determine the type of crystallization.

The resultant Pyroceram material is an opaque ceramic the same shape and size as the original glass article. (Minute volume charges—less than 1 per cent—due to altered density and expansion coefficient of the crystalline material may be expected).

Two types of glass-ceramics, Pyroceram Code 9606 and Code 9608, are available in commercial quantities. Pyroceram 9606 was specifically developed to give uniform electrical properties at microwave frequencies and elevated temperatures for missile radomes. However, other desirable properties—high strength, hardness, and abrasion resistance—make it suitable for uses in other fields. Pyroceram 9606 can be ground and polished in its glassy and crystalline states by conventional finishing processes. In color it ranges from an off-white to cream. It is non-porous and shows no increase in weight after long submersion in water.

Pyroceram 9608 can be formed into any conventional glass shape. Such objects as flasks, beakers, evaporation dishes, and other laboratory equipment can be made; such varied pieces as cylinders, godet wheels, pump parts, pipe caps, thread guides, and globes have been made, giving evidence of versatility in forming.

The hardness and low expansion coefficient of Pyroceram 9608, plus its ability to be easily formed, have brought the material to the attention of bearing manufacturers. Tests indicate Pyroceram 9608 bearing surfaces will operate under varying temperature and load conditions while showing excellent galling or wear characteristics. Because of the materials fine-grained structure, wear paths, when shown, have been even and smooth with minimum wear and friction values.

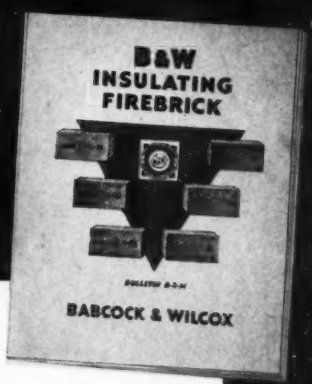
Tubing is being tested for use in heat exchangers, particularly where temperature differentials are great and where slurries or liquids with abrasives are being run through the exchanger. Greater hardness, higher strength, and better thermal conductivity than glass, combined with thermal shock resistance, make the tubing an excellent material for high temperature heat exchangers.

(*Continued on page* 40)

Why B&W IFB for Glass Furnace Insulation ?

- Lightest weight
- Lower conductivity
- Lower heat storage
- High hot load strength
- Simplified construction
- Lower temperature around tank

*



Since B&W IFB are lighter than other insulating firebrick, they insulate better. Thus, they save more fuel.

The higher insulating value and lower conductivity of B&W Insulating Firebrick reduce radiation, which is lost heat. This not only results in lower fuel costs, but also provides better working conditions around the tank for glass furnace operators.

In addition, B&W IFB offer excellent refractory qualities. They have ample hot load strength to prevent deformation. Shrinkage is negligible. B&W IFB are easy to handle, install and cut to form special shapes, using only wood working tools.

Lightweight B&W IFB save in other ways, too. They can be bonded with firebrick walls to reduce air leakage and air infiltration, further reducing fuel consumption.

****Write for Bulletin R-2-H giving more data on B&W Insulating Firebrick.***

B&W REFRACTORIES PRODUCTS:
B&W Alimul Firebrick • B&W 90 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

(*Continued from page* 38)

Other applications of this material under consideration include: consumer kitchenware, curtain walls, structural parts for aircraft and missiles, air compressor blades, jig fixtures for high temperature brazing, and piston heads. Raw materials for the manufacture of Pyroceram glass-ceramics are readily available in non-strategic glass batch materials.

Glass-ceramics are approximately 40 per cent harder than borosilicate glass, as measured with indentation tests. In their initial glassy state, they can be ground by standard glass finishing methods. Precision grinding can be easily done on Pyroceram 9606 and 9608 in their crystalline states.

Because all Pyroceram products are transparent in the initial stages, they can be inspected visually for internal defects before final processing. Equal thermal expansion of the glass-ceramic in all directions is assured by the nature of the material, which is isotropic in its glassy state.

Pyroceram glass-ceramics are not ductile materials. Direct substitution for other materials having the same nominal strength should be reviewed for proper design. In view of the critical heat cycles involved in the last state of manufacturing Pyroceram, all heat treating will be done by Corning. Pyroceram in its glassy or untreated state will not be sold, either as an end product or as a component.

Cercor

Extremely thin-walled ceramics formed into lightweight honeycomb structures capable of operating at high temperatures have been introduced by Corning Glass Works.

These materials, made by the new Cercor process, can withstand temperatures up to 1000°C. (1800°F.) with virtually no thermal expansion and can operate continuously at 700°C. (1290°F.). At these temperatures they are resistant to oxidation and corrosion. A unique characteristic of these materials is their extremely low coefficient of thermal expansion: 1 x 10^{-7} per degree C (from 0 to 300°C.). They can withstand extreme thermal shock.

The extremely low expansion at high temperatures and high surface area of Cercor process material indicate their future use, says Corning, in gaseous heat exchangers, as catalyst supports, and as structural materials for use at elevated temperatures. It is possible to build Cercor structures having a wide range of shapes and properties. The base material can be of any of a large number of ceramic compositions.

Pyroceram is used as one of the base materials for available Cercor pieces. Disks 20 inches in diameter and 3¾ inches thick have been made by the Cercor process. A protective rim for the disk is formed by a tough coating of special material with matching expansion and equally high resistance to temperatures.

The new structures can also be used as air preheaters and aftercoolers, as burner plates or covers, column packing material, or as architectural materials where lightness, thermal shock resistance and high temperature strength are requisites.

Available Cercor pieces have a compressive strength, parallel to the channels, of 2000 psi. Surface area of the 20-hole-per-inch corrugated structures is 1500 square feet per cubic foot of material. Of the total face area, 75 to 80 per cent is open space. Hole sizes of Cercor pieces are approximately 0.095 inch long and 0.045 inch high. It is believed that the cellular holes can be formed into a variety of shapes with a wide range of dimensions. The material has a density of about 30 pounds per cubic foot and a specific heat (room temperature) of 0.20. The average wall thickness of the corrugated structure is 0.005 inch.

High Temperature Ceramics

Manufactured for high temperature uses where material expansion is critical, Corning's lithium-aluminum-silicate low-expansion ceramics are formed in a variety of shapes by slip casting, hydraulic pressing, and extrusion.

One ceramic, known as E-313, has a zero coefficient of expansion and can be used continually at temperatures up to 1830°F; short term temperature peaks can go up to 2100° F. With a flexural strength of 8000 psi, this ceramic is gas tight and has a specific gravity of 2.3. Good mechanical strength coupled with zero expansion gives E-313 excellent thermal shock resistance.

The materials are particularly resistant to molten aluminum and are being investigated for use as furnace linings for aluminum melting tanks and for molten aluminum containers. Other potential uses include kiln furniture, crucibles, firing supports in industrial and laboratory furnaces, and calcining trays.

Telescope Mirror Blank

A giant telescope mirror blank 84 inches in diameter and 13 inches thick will be produced by Corning Glass Works for the National Observatory to be constructed near Tucson, Arizona. Delivery is expected in June, 1959. This date will mark the 25th anniversary year for casting the world's largest single piece of glass, the famed 200-inch disc for the Hale Observatory on Palomar Mountain in California.

The 84-inch mirror will be installed in a Cassegrain telescope atop Kitt Peak, about 40 miles outside of Tucson. It has been ordered by the Association of Universities for Research in Astronomy, which will operate the observatory.

Industrial Filters

Porous materials with particle retention ranging from 2 to 120 microns are now being produced in a wide range of sizes and shapes. Used for industrial filters, the materials perform like a mechanical screen. They are non-sloughing, an important advantage to industries faced with the problem of shedding and passing of filter body particles. The materials combine high mechanical strength with chemical and thermal shock resistance.

Their uniform structure provides accurate control over particle retention. A filter rated at 50 microns, for example, will retain 98 per cent of all particles larger than 50 microns.

(*Continued on page* 42)

WORKS WELL IN ANY WEATHER

Whatever the atmospheric conditions – cold, hot, humid, dry – you can depend on Drakenfeld Colors in Drakotherm for fine workability.

Drakenfeld Colors in Drakotherm, the quick-setting thermoplastic printing paste, are the first choice of most glass container decorators. This medium is the result of nearly 10 years of research and plant experience in hot color printing by fully automatic machine.

Drakenfeld Colors in Drakotherm print smoothly, are smooth and sharp in detail, smooth and glossy after firing.

To the all-weather workability of Drakenfeld Colors in Drakotherm you can add fast, economical hot color printing. Learn how they can cut decorating costs for you. We will gladly discuss details at your convenience.

★ ★ ★

DEPENDABLE SERVICE ON: Acid, Alkali and Sulphide Resistant Glass Colors and Enamels . . . Silver Paste . . . Crystal Ices . . . Porcelain Enamel Colors . . . Body, Slip and Glaze Stains . . . Overglaze and Underglaze Colors . . . Squeegee and Printing Oils . . . Spraying and Banding Mediums . . . Metallic Oxides and Chemicals.

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BRAUN-KNECHT-HEIMANN COMPANY, 1400 Sixteenth Street
SAN FRANCISCO 19, California Phone: HEmlock 1-8800

(*Continued from page 40*)

Fotoform Glass Screens

Automatically produced glass screens with 562,500 precisely etched holes per square inch are now available. With excellent dielectric properties, the screens are particularly suitable for electronic storage tubes and for targets in image orthicon tubes. Transmission of these screens can be as low as 40 per cent or as high as 70 per cent, depending on width of the holes. These range from 0.00085 inch to 0.00112 inch.

The new screens are made of Corning's Fotoform, a strong, chemically etchable photosensitive glass. With an etching ratio 15 times higher than that of conventional glasses, Fotoform can be chemically machined in a screen pattern with submicroscopic, square-cornered holes, each of which is less than half the diameter of a human hair.

Thickness of the circular screens after etching is 0.003-0.005 inch. Largest size now available is 1.750 inches in diameter with a screen diameter of 1.500 inches.

Glass to Metal Seals

Pyroceram brand cement can be used for sealing metals and glasses. Unlike most cements and solders, service temperature of this cement is identical to its sealing range, 400-450°C.

The new cement can be used to seal most glasses, including lead, lime, and barium-flint types, ceramics to glass, ceramics and metal to glass, and metal to metal, such as chrome and nickel stainless steels. It is now being used to seal the face panel to the funnel of all-glass color television bulbs.

A short heat treatment at 450°C. transforms the toothpaste-like cement into an extremely strong, white ceramic-like material. In most glass-to-glass seals the ceramic bond is stronger and harder than the parts, even at elevated temperatures. Materials to be sealed with Pyroceram brand cement must have an expansion between 85 and 110 x 10^{-7} inch per inch degree C and be able to withstand a 400-450°C. sealing temperature.

Vycor Tubing

Tiny pieces of Vycor brand glass tubing are helping engineers solve problems caused by high temperatures in modern jet engines. Pieces of the glass tubing are fixed to the inside of a precision casting mold; then hot metal is poured into the mold to form parts such as jet turbine blades. After the metal has cooled, the glass is dissolved leaving a hollow core. Then, when the jet turbine is operating, cooling blasts of air can be blown through the blade, lowering its temperature and enabling the engine to operate faster and hotter.

The tubing is made of 96 per cent silica glass, which can resist sudden and extreme temperature changes. A laboratory crucible made of this material can withstand the double shock of ice on one side and molten metal on the other. In the new casting process, it stands temperatures over 3,000°F.

High-Energy Absorbing Glasses

A new high lead content glass designed to stop ultra-high energy particles in a Cerenkov spectrometer has been developed. Tailored specifically to meet requests of nuclear physicists for better material with which to measure the energy of the particles, the new lead glass is said to permit better energy resolution than any glass currently used in these spectrometers.

The purpose of glass in the Cerenkov counter is to stop high energy particles such as protons, electrons, or photons, causing them to emit light, which is in turn measured by a multiplier photo tube. Measurements have heretofore been restricted by the optical quality of the glass. The new glass, which is crystal clear, will allow more accurate measurement of the total light output.

The water-white glass has a specific gravity of 4.03 and an index of refraction of 1.724. Weighing 282 pounds per cubic foot, the glass will first be made into cylinders up to 12 inches in diameter and 14 inches thick.

Atomic Portholes

Atomic "portholes," weighing half a ton or more are being manufactured for the U. S. Navy. These gigantic sight glasses are actually combination radiation shielding windows used as peep-holes into radioactive compartments.

Radiation shielding glass of high lead content and Plexiglas, a plastic material, are used; the Plexiglas, to protect observers against neutrons, and the high density glass, against gamma rays.

The windows are part of a line of radiation shielding units manufactured by Corning. Ranging in size from small bricks of glass to windows five feet thick and weighing nine tons, these radiation shielding glasses have found extensive use in experimental "hot" laboratories used for nuclear development programs.

Dosimeter Glass

A new type of high-level dosimeter glass for "reading" irradiation of foods and drugs is available. The glass was specifically tailored to extend radiation dosage response sensitivity to the 1-5 megaroentgen range. Detailed evaluation of the range and stability against fading of the glass has shown it to be superior in most respects to current practical dosimeters.

After dosage of 1,000,000 rep, and with no stabilizing heat treatment, optical density readings of the new glass taken eight days after irradiation fade no more than 10 per cent. The dosimeter glass, which is sensitive to both beta and gamma rays, is particularly suitable for reading the high level irradiation of food and drugs. It allows direct reading of radiation dosage by defined color changes.

(*To Be Concluded*)

Glass Container Molds

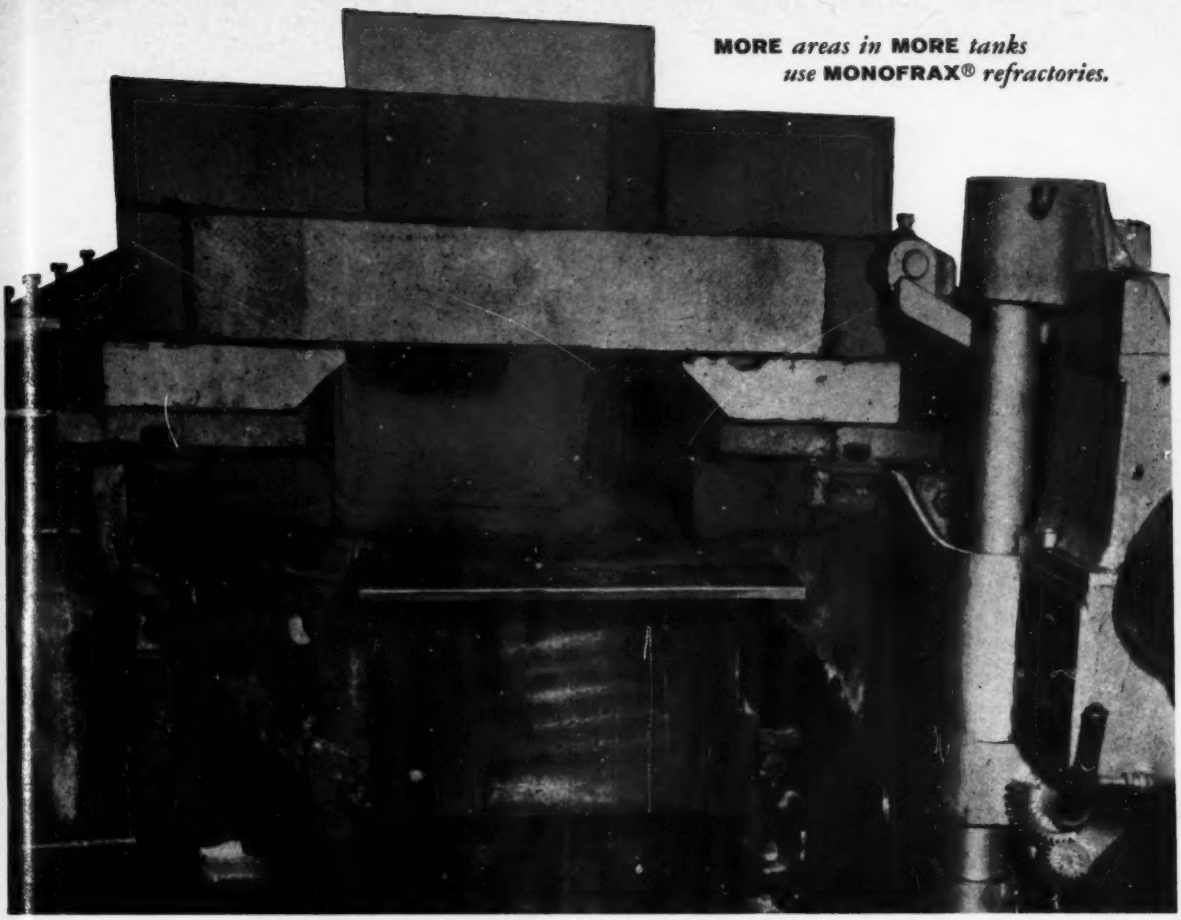
(*Continued from page 23*)

parts, obtained in view of largely agreeing values of chemical analyses, indicate that there were differences in the microstructure. As will be seen, the carbon equivalent, taken as C + ⅓ Si, is practically the same in all cases and conforms to a eutectic composition.

A photomicrograph of the working surface of the blank mold is shown in Fig. 1 and that of a section taken from the center of the same blank mold appears in Fig. 2. It will be noted that on the working surface, ferritic cast

(*Continued on page 44*)

MORE *areas in* **MORE** *tanks use* **MONOFRAX®** *refractories.*



FEEDER CHANNEL is one of four in this tank that are lined with MONOFRAX M refractory. It was chosen because it is highly resistant to erosion and avoids refractory contaminates. Tank is end fired and melts clear, soda-lime glass.

This feeder channel typifies special-purpose areas that need a special-purpose refractory

The feeder channel pictured above uses MONOFRAX M fused-cast refractories—from feeder entrance up to feeder bowl. Here are the reasons:

(1) MONOFRAX M refractory resists erosion with exceptional success. That's because the refractory crystals are small and tightly interlocked.

(2) It also minimizes refractory-caused contamination. In fact, it's *the* purest of all commercial fused-cast refractories. It consists of over 98% alumina with less than 0.2% impurities. These properties of Type M also explain its use in the complete melting-end sidewalls. (MONOFRAX H refractory is used in the tuckstones, port bottoms, bridge wall runners and shadow wall in the tank described here.)

Four MONOFRAX compositions make up a complete line that is designed to meet *all types of tank* service. Each is peculiarly suited for certain glass compositions . . . tank designs . . . or tank areas. Our engineers have the experience—*and the special-purpose refractories*—to help you deliver quality glass at lowest refractory cost. So make a mental note to exchange thinking with our local refractory engineer. For his name, write: The Carborundum Company, Perth Amboy, N. J., Dept. L-19.

CARBORUNDUM

Registered Trade Mark

(*Continued from page* 42)

iron shows an almost cluster-like occurrence of graphite which becomes coarser toward the center, the flakes being linked to each other. Beside the phosphide eutectic, there are fine carbides, titanium carbides, and manganese sulfide.

Photographs of the working surface and center section of the baffle are shown in Figures 3 and 4, respectively. On the working surface of the ferritic cast iron, fine

Fig. 7. Electron Microscope View of Seam (8000X)

graphite is found partly in a cluster-like formation and partly alongside the ferrite dendrites. Toward the inside, the graphite becomes coarse and predominantly cluster-like.

Figures 5 and 6 show the working surface and center of a blow mold. On the working surface, the graphite is arranged in clusters. Toward the inside, the graphite becomes very coarse-lamellar. Beside the phosphide eutectic there are many titanium carbides and other carbides. The influence of clustered graphite laminae becomes apparent with a study of the working surface in Fig. 5.

Here it is noticeable how outcropping coarse graphite laminae offer possibility for attack and thus favor chip-offs and reactions between the metallic matrix of the mold and hot vapors from glass and mold lubricants.

It was found that the bigger graphite flakes, close to the working surface, were surrounded by brownish-colored seams. In order to learn more about the nature of these seams they were examined with an electron microscope. Fig. 7 shows one of the seams, magnified about

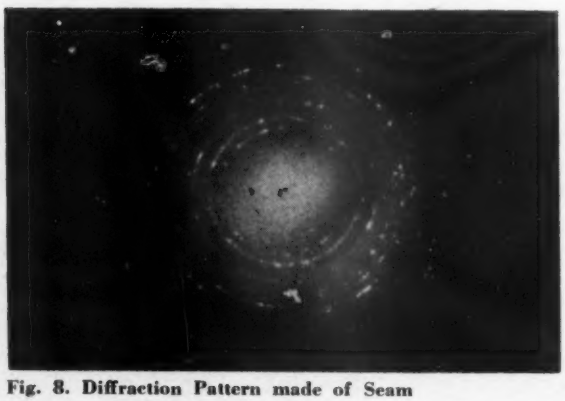


Fig. 8. Diffraction Pattern made of Seam

8000 times. It shows chemical attack alongside the graphite flakes.

To identify the products of reaction, an electron diffraction pattern was made (Fig. 8). This pattern indicates the existence of Acmite, $NaFe\ (SiO_3)_2$, and Augite, $CaO\ (MgFe)\ 0.2\ SiO_2\ (AlFe)_2O_3$, or similar mineral-like deposits resulting from the penetration of hot glass vapors into the crevices along loosened graphite flakes.

Acmite predominantly forms at temperatures between 1450°F and 1650°F.

It is possible that still other compositions were formed at other spots or that several other compositions exist side by side. Evidence of iron oxide, graphite, and cementite were not found in the diffraction diagram.

Results and Conclusions

The results of the examination of these particular molds and mold parts, and an examination of other molds which have been used successfully in producing over ½-million containers, again confirm that the formation of the microstructure is of great importance in determining the suitability of a mold material. In the case of the cast-iron molds reported here, although their chemical compositions were similar, they showed deficiencies in the formation of the structure. Furthermore, these studies show that there is a definite relationship between unfavorable graphite formation and destruction of the working surface. In two bottom plates examined, the penetration of oxidizing gases alongside the graphite streaks were noticed. Also, the bottom was permeated by remnants of pearlite, which indicated an unstable structure. These rests of pearlite decompose at a certain temperature range and cause an increase in volume.

Based on these studies, it can be concluded that repeated heating and cooling may cause mold failure by forced widening or loosening of the structure in the mold face, alongside the graphite streaks. This permits the penetration of hot vapors from glass, mold lubricants, and air into the fissures. These vapors react with the iron walls to form brittle, mineral-like compounds. As these reaction phenomena occur at temperatures above 1450°F, it is apparent that sufficient cooling is important in determining mold life and efficiency.

At Emhart we are continuing our glass mold research. Other findings will be reported in subsequent articles.

Inventions and Inventors

(*Continued from page* 31)

There were 3 claims and the following references cited in this patent.

United States Patents

682,365, Mount, Sept. 10, 1901; 1,889,510, Amsler, Nov. 29, 1932; 1,928,598, Morton et al., Sept. 26, 1933; and 2,455,907, Slayter, Dec. 7, 1948.

Glass and Wool Fiber

Glass Fiber Article and Process of Plural Coated Fiber and Process of Preparation. Patent No. 2,801,189. Filed October 8, 1952. Issued July 30, 1957. No sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Theodore J. Collier.

This invention relates to the treatment of glass fibers for use in combination with resinous materials in the manufacture of reinforced plastics and laminates and in the production of coated fabrics.

The following will illustrate the formulation of a saturated polyester, free of cross-linking, which may be used in compounding a size composition embodying good performance and good handling characteristics upon application to the glass fibers in forming:

	Grams
Succinic anhydride	1700
Propylene glycol	1400
Triphenyl phosphite	1.67

The materials are combined and reacted with stirring in a stainless steel container fitted with a tight closure having a stirrer suspended therefrom and fitted for bubbling an inert gas, such as nitrogen or carbon dioxide, through the reaction mix and also vented through a condenser to prevent loss of ingredients with the inert gas circulated through the container to maintain an inert atmosphere. Reaction temperatures of about 165°C are maintained for about 8 hours, and then the reaction is continued at about 200°C. until an acid number of about 25-30 is reached.

The reaction at 200°C takes about six additional hours. Reaction is then stopped by dilution to about 50 per cent solids with suitable solvents, such as acetone and the like for solution or dispersion in aqueous medium with ammonium hydroxide, or the reaction may be stopped by cooling the mix to a lower temperature by other conventional means. Instead of making use of an inert atmosphere for refluxing, the ingredients may be reacted in a solvent system using about 3 per cent by weight toluene or xylene.

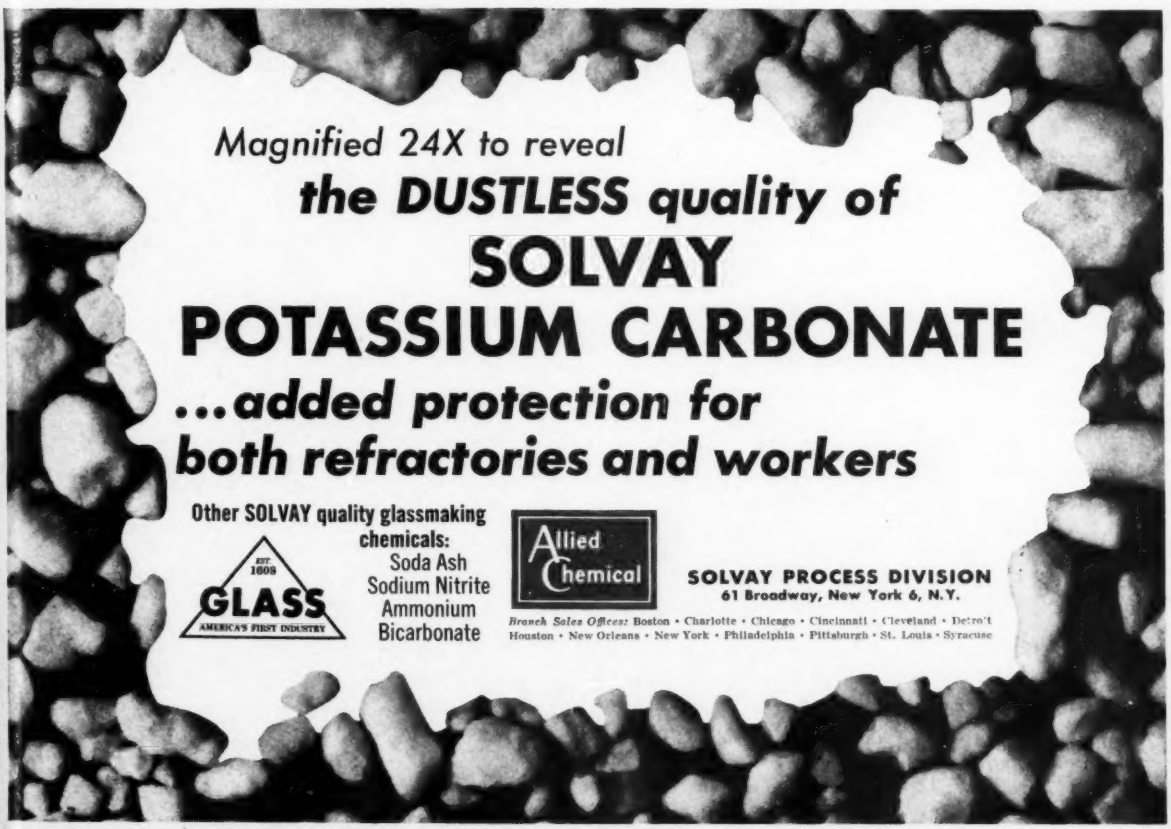
There were 13 claims and 14 references cited in this patent.

Process and apparatus for the production of mineral and slag wool. Patent No. 2,810,158. Filed October 15, 1952. Issued October 22, 1957. One sheet of drawings; none reproduced. Willem Cornelis Petrus Smout.

The present invention is based upon the general principle of carrying away the poured stream of slag gradually over a longer distance than heretofore, instead of atomizing it all at once as is usual in known processes. For this purpose, the atomizing medium, for example air or steam, is caused to act on the descending stream of slag substantially at right angles to the direction of flow thereof and over a length which is greater than twice its thickness. The length of the zone of action preferably amounts to 8-12 times the thickness of the stream of slag.

The atomizing medium is directed in the form of two wide flat bands on to the two sides of the stream of slag so that the said stream is gradually carried away from the sides and is drawn out into the form of wool. The atomizing medium is thus directed substantially tangentially on to the stream of slag.

In a preferred construction of apparatus an aperture is provided between the slots for the passage of air, arranged so that no eddying occurs between the two bands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of atomizing medium which act on the stream of slag and no undesirable influence is exerted on the latter, so that it is actually laterally acted on by the atomizing medium.

Further, a number of apparatus may be arranged in juxtaposition to one another thus blowing a number of streams issuing parallel to one another. In this case, jets of smaller thickness can be employed than when a single thick jet is fed to the atomizing arrangement.

There were 12 claims and the following references cited in this patent.

United States Patents

299,111, Burns, May 27, 1884; 436,244, Kennedy, Sept. 9, 1890; 721,293, Fuchs, Feb. 24, 1903; 1,245,328, Freeman, Nov. 6, 1917; 1,650,136, Koberle, Nov. 22, 1927; 2,308,584, Best, Jan. 19, 1943; and 2,330,038, Ervin, Sept. 21, 1943.

Sheet and Plate Glass

Mirror making apparatus. Patent No. 2,816,303. Filed October 26, 1951. Issued December 17, 1957. Four sheets of drawings; none reproduced. Assigned to W. P. Fuller & Co. by Max Klaar.

This invention relates to improvements in automatic mirror making machines and has particular relation to a device for cleaning off unwanted silver and paint and other foreign matter from the unsilvered side of the glass when the silvering operation has been completed.

There were 17 claims and the following references cited in this patent.

United States Patents

1,289,260, Powanda, Dec. 31, 1918; 1,817,332, Worrall, Aug. 4, 1931; 1,953,352, Kranich, Apr. 3, 1934; 2,272,729, Searing, Feb. 10, 1942; 2,321,179, Boyer, June 8, 1943; 2,542,205, Mort, Feb. 20, 1951; 2,525,166, Brown, Oct. 10, 1950; 2,525,178, Miller, Oct. 10, 1950; and 2,563,224, Dunkerly, Aug. 7, 1951.

Glass enclosure. Patent No. 2,808,355. Filed June 11, 1956. Issued October 1, 1957. Two sheets of drawings; none reproduced. Assigned to North American Aviation, Inc. by Peter S. Christie, Lester G. Hall, and Francis A. Rutkosky.

This invention pertains to a glass enclosure and more particularly to a windshield enclosure for a vehicle such as an aircraft.

The mounting of glass panels, such as for windshields, has always involved certain problems due to the nature of the glass material. It cannot withstand bearing loads such as imposed by a bolted connection, so that it has been customary to provide some manner of projection from the edge of the glass which may be bolted or otherwise secured to a mounting frame.

For modern aircraft, a mounting arrangement is generally some sort of device cemented to the edge of the glass and extending to the structural portions of the aircraft. There is difficulty in providing a cemented connection of sufficient strength to withstand the forces imposed by the aircraft when in flight. The cemented connections are relatively strong in shear but subject to failure from peeling. Also moisture and weathering are known to have deleterious effects on cemented joints. There are additional problems of providing a mounting of minimum opaque area, resistant to high temperature, vibration and other adverse conditions.

The device of this invention includes the provision of a metalized marginal portion on a glass panel, to which is cemented a fabric loop. Also included are fabric attaching strips extending from the loop and stitched thereto so that side loads will be taken in shear by the loop along the edge surface of the glass. The fabric projections include metal strips bonded thereto for receiving bolts and attaching the glass to adjacent structure. A fairing, sealing and shock absorbing material is also provided around the mounting structure between the same and the glass, this preferably being applied by an injection process.

There were 11 claims and the following references cited in this patent.

United States Patents

1,826,865, Carr, Oct. 13, 1931 and 2,683,678, Adams, July 13, 1954.

Tube and Cane Machines

Tubular lamp bulb machine. Patent No. 2,835,079. Filed June 30, 1953. Issued May 20, 1958. No sheets of drawings; none reproduced. Assigned to Westinghouse Electric Corporation by Frank J. Camarata and Charles Wiener.

A machine for forming shoulders in a glass tube and severing the glass between contiguous shoulders is described. The tubing is first softened by a battery of gas-fired burners and the shoulder formed by an advancing tool so regulated to form the desired depression in the glass. An electrical circuit controls both the advance of the tool and the valve which controls the amount of fuel, which in turn regulates the amount of heat applied to a predetermined portion of the tube. After forming, the cooled tubing is severed automatically.

There were four claims and 18 references cited in this patent.

Method and apparatus for producing tubes of vitreous materials. Patent No. 2,826,869. Filed March 14, 1955. Issued March 18, 1958. No sheets of drawings; none reproduced. Assigned to Glasund Spiegel-Manufactur Act.-Ges. by Walter Lerch.

The principal features of the invention consist in the use of a rotatable mold which is preferably slightly inclined to the horizontal; in feeding the melt intermittently and drop by drop into the mold; and, while thus feeding the melt, in successively, although preferably intermittently moving the mold away from the inlet point of the melt, or in depositing the melt intermittently side by side within the mold.

The new method of feeding the melt drop by drop into the mold has the considerable advantage over prior methods that the vitreous mass may be fed at a much higher speed than when it is fed in a continuous stream, since the individual drop or slug will hardly cool off while being inserted into the mold.

The first drop or slug will then pass to the end of the mold directly opposite to the place of insertion, and the rotation of the mold will shape this drop into a ring. Shortly, thereafter, the second drop follows and, by the

lateral travel of the mold, it will be deposited next to the first ring and form a second ring which through the centrifugal force fuses together with the first ring so as to form a single unit. This continues until the mold will be filled entirely. Although not absolutely necessary, such depositing of the successive slugs of molten material and the fusion of one ring of material to the preceding ring may be facilitated by slightly inclining the entire mold so that the molten material has the natural tendency to slide toward the preceding ring to combine therewith.

The resultant tubes are more homogeneous, free from bubbles, spiral threads and the like and are readily removed from the mold.

There were 12 claims and the following references cited in this patent.

United States Patents

1,058,250, Millsbaugh, Apr. 8, 1913; 1,377,372, Thompson, May 10, 1921; 1,562,551, Hall, Nov. 24, 1925; 2,108,371, French, Feb. 15, 1938; and 2,121,143, Engels, June 21, 1938.

Foreign Patents

634,847, France, Dec. 9, 1927; 361,090, Great Britain, Nov. 19, 1931; and 504,812, Great Britain, July 24, 1937.

Miscellaneous Processes

Method of Making A Glass Fiber Reinforced Resinous Product. Patent No. 2,798,029. Filed June 23, 1953. Issued July 2, 1957. Assigned to L. O. F. Glass Fibers Company by Emil H. Balz, Leroy F. Ornella and Jaclyn Villwock.

A method of making a glass fiber reinforced resinous product, forming a plurality of fine glass fibers from molten glass. The fibers are coated as they are formed with a binder composition comprising an aqueous emulsion having from 1 to 15 per cent by weight of polyvinyl acetate, about 0.25 to 2.5 per cent of a liquid polyhydric alcohol and an amount of acid such that the pH of the emusion is between about 2.5 and 4.0. grouping. Said fibers are then grouped into a strand.

ERRATUM

It has come to our attention that the first two complete paragraphs on page 614 of the November, 1958, issue are in error. This portion of our report on Dr. Alexander Silverman's paper delivered at the Glass Division Bedford Springs meeting is inaccurate and should be omitted.

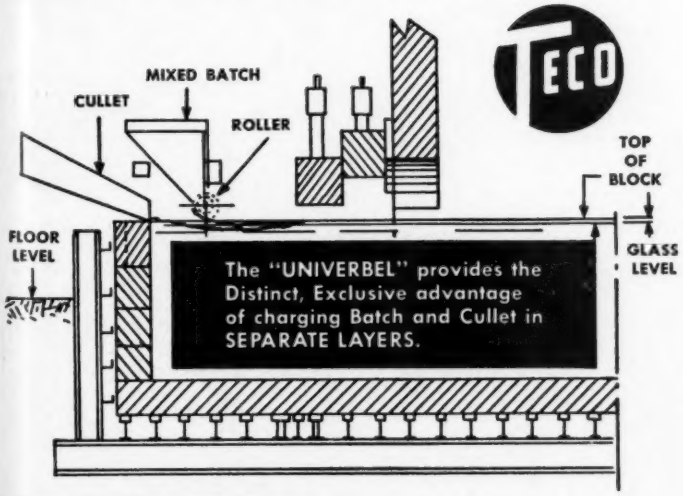
Nineteenth Conference on Glass Problems

(*Continued from page* 29)

for a 25-minute period. Only after 48 hours was the tracer well diffused within the glass. These tracer tests substantiated previous generalizations and showed that the glass furnace was not an efficient mixer.

(*Continued on next* page)

Better Glass with 'UNIVERBEL' Batch Charger



The unique "Univerbel" Batch Charger for feeding batch and cullet to glass melting furnaces was developed and perfected in Belgium and is being used with exceptional success in many European countries as well as Great Britain, Canada and the United States.

It is ideally suited for charging melting furnaces in plants producing WINDOW GLASS, PLATE GLASS, CONTAINERS, GLASS BLOCK, GLASS WOOL, GLASS FIBER and many other materials and products.

◀ Illustration at the left shows the "Univerbel" charger in a sectional drawing of the doghouse into which the batch and cullet are fed by the charger. Rotation of the Feeding roll moves the batch and cullet into the furnace.

Write or Phone FOR FURTHER INFORMATION

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The following changes were made in a plate glass furnace to improve the quality of production:

1) The total furnace port area was reduced and redistributed.
2) The depth of the glass reduced from 59 inches to 47 inches.
3) The crown was raised approximately 12 inches.
4) The fuel was changed from coke to natural gas.
5) A conventional low-pressure burner system was installed.
6) The batch mixer was changed from a "pugmill" type to the "tumbler" type.
7) The batch mixer conveying mechanism was streamlined to minimize mechanical failures.
8) The batching system was made automatic, and suitable protection devices were installed.
9) Specific furnace sidewall block refractory types were changed.
10) Modifications were made in order to increase the available draft.
11) The ribbon width was increased from 52 inches to 103 inches.

The average furnace output was increased from 136 tons per operating day per campaign to approximately 200 tons. In addition, ream was reduced from its "Number One Public Enemy" status to that of insignificance.

Cords Resulting from Glass Melting

The fourth Friday morning paper was "Cords Resulting From Various Types of Glass Melting," by Carl J. Uhrmann, Arthur W. Schmid Company. Attempts were made to describe the similarity in the occurrence of the problems which are common to all types of glass melting.

The oldest type is the open pot which, during the whole period of development of the glass industry from a highly specialized art to its present commercial importance, has undergone only changes in size and substantial improvement in quality of refractory material.

A long time ago the way to improve the glass quality in open-pot melting was discovered, and various methods and devices for stirring the glass during the melt were developed. The oldest of these is the "boiling" or "rubbing" of the glass during the melt which we today call "bubbling," and its skillful use has greatly reduced the presence of cords and waves in the finished glass products.

Cords are formed during melting in covered pots in the same manner as in open pots, except that the chances of more cords from the clay of the pots are increased. Particularly where it is the practice to fill a covered pot in one single charge, piling the batch materials high on the walls, excessive corrosion of the pot walls and hood follows. This increases the amount of cords which are difficult to diffuse in the glass. To promote agitation and mixing during melting, and thereby aid the dissolving of cords in the glass, various methods have been tried, for example, filling of cullet in a separate charge on top of the batch. Preparation of two batches, calculated so that one results in a glass of lesser density than the other, has also been tried for improving the glass

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- General industrial lubricant
- Parting compound

Descriptive literature and working samples on request.

GRAPHITE PRODUCTS CORPORATION
BROOKFIELD, OHIO

quality. A more effective method is the introduction of materials into the batch which will contribute gases, and promote the blending and mixing during melting.

Melting in day tanks presents added problems because, in addition to cords prevalent in pot melting, a number of new sources of defects in the glass are introduced. In day tanks of the usual square or rectangular shape, it is difficult to obtain uniform distribution of heat, and the corners are a particular source of trouble.

For the production of sheet or plate glass, continuous furnaces of the side-port type are used which are especially designed for melting and refining of the glass at a slower rate than in furnaces for other glass production. The refining or conditioning chamber usually is nearly as long as the melting tank. The prolonged time of melting allows more complete solution and absorption of the cords from the batch, as well as the refractories.

Continuous melting furnaces for the production of containers and tableware are designed along different lines. They are operated at considerably higher temperatures, and they must produce a larger tonnage per square foot of melting area than sheet glass furnaces. The melting is separated from the working end of the tank and usually a throat connects the two chambers. This provides the means for reducing the glass temperature from melting to working conditions quickly, and within a short distance. Due to the high melting temperatures needed for increased rate of melting, the rate of forming of cords from solution of refractories is considerably increased.

The throat, as well as the working chamber of the furnace can contribute additional cords to the glass. Rapid wear of the throat blocks increases the cord problem, and this usually can be traced to improper cooling. Some cords and waves in the glass, which are formed in the working end, can be attributed to uneven temperature conditions and wear on refractories.

Cross-fired, or side-port type, furnaces are mostly designed for large-tonnage production. For more limited output, end-port type furnaces are frequently used. The flame from the ports follows a semi-circular pattern. In the early development of end-port tanks, the trend was toward longer and narrower furnaces. More recently, a nearly square shape has found preference in the industry. The wider and shorter melting tank provides a more free passage for the flame and substantially more effective coverage of the melting surface from the U-shaped flame. The control of cords in an end-port tank appears as a more complex problem because of the tendency of the flame to cause uneven heating between reversal.

Control of Cords

"The Control of Cords and Homogeneity in Glasses," by James Poole, Brockway Glass Company. The most common cause of cords is batch variation, but it may also result from poor furnace operation, changing conditions of melting, refractory corrosion, and volatilization of some component or components from the melt. One or all of these may be contributing simultaneously to a cord problem.

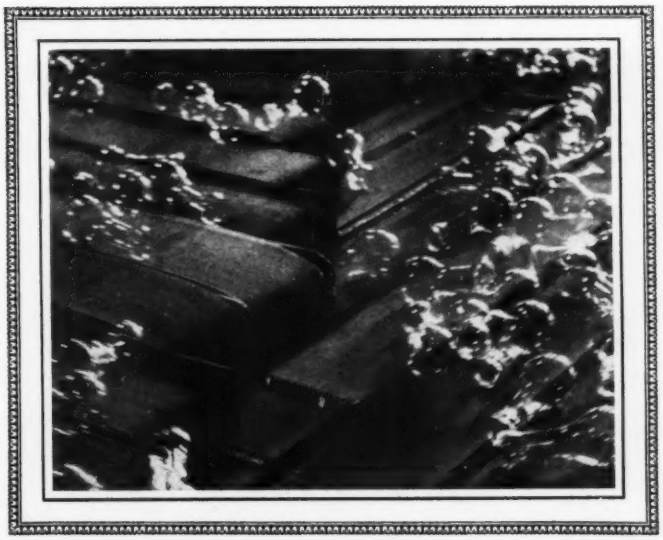
Previous work has shown that density samples must

How well do you know your glass?

HERE YOU SEE:

- ☐ 1. Glass Christmas-tree ornaments
- ☐ 2. Decorative glass bubbles
- ☐ 3. Florence flasks
- ☐ 4. Machine for mass production of lamp bulbs

No. 4 is the right answer. The first electric lamp bulbs were hand blown and expensive. Then in 1926 the development of the ribbon machine changed production radically – to 2,000 bulbs per *minute* compared with 150 bulbs per *hour* previously! In supplying Soda Ash to the glass industry for nearly 70 years, Wyandotte, too, has kept pace with improved techniques. Today, as in the past, Wyandotte is a working partner supplying technical assistance and raw-material chemicals to those great companies marking milestones in the glass progress.



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Charles Eisler, Jr.
President

Delos M. Palmer
& Associates
Consulting Engineers
Mechanical, Electrical & Industrial
Designers of
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be taken at least every 4 hours if process control is to be achieved, for this permits accurate spotting of the time of an upset, if one should occur. Also, when samples were run at 24-hour intervals, it was found that certain types of cyclic batch errors could pass through their maximum change and back again in this period, and while the data indicated no change, actually a sizeable density change (about .0020) was occurring daily.

Cords are then really more a function of the time rate of change of density (or composition) than of absolute value. A change of .0040 gm/cc in 8 hours could be disastrous, while the same change over a several-day period would hardly be observed.

In addition to these measurements, data are recorded daily on color, seed count, and on all furnace conditions such as temperatures, pressure, combustion conditions, feeding cycle, level, and flame coverage (visual). The batch house scales (manual or automatic) are cleaned and checked daily for sensitivity, zero and full-load balance, and over and under protection sensitivity.

The following items of data are plotted on control charts daily: Tonnage, bridgewall temperature, nose temperature, first port temperature, average cord grades, average seed grades, color, density (8 a.m., maximum, and minimum for 24 hours), low temperature viscosity, average batch weights, and car unloadings.

Center lines, and upper and lower control limits are kept up to date, and no change in any variable is permitted to occur beyond its control limit without causes being assigned. With all these tools to work with, trouble shooting becomes simply a matter of staying out of trouble as interpretation of these data permits preventive or corrective action to be made before any significant cord can result.

Composition control, which results in cord control, is accomplished by the simultaneous evaluation of a number of variables related to the batch and melting processes.

Rapid changes in homogeneity, accompanied by density and viscosity changes, usually indicate a batch problem. Analysis of the control data will usually reveal that the material is at fault and will indicate the size of the error. A check list of potential batch house trouble points is helpful at this point. Batch is also indicated as a source if the cord is laminar or onion-skin in appearance.

With the control system described, cord-free glass (B to B– ware grade, B– to C+ glass grade) has resulted continuously for a number of years. Some variation in glass grade occurs (compression cord) but this does not affect the packability of the ware.

Melting Methods for Cord Control

The final paper of the Conference was "Melting Methods for Controlling Cords in Glass," by Larry Penberthy, Penberthy Electromelt Company. A method of approach, somewhat different from that given by previous speakers, was presented by Mr. Penberthy. The methods considered were to provide local turbulence in the molten glass, that is, turbulence having the dimensions of one to three feet for a complete whirl. The methods considered were: mechanical stirring, electrothermal stirring, and pneumatic stirring (bubbling).

Small-scale turbulence has been achieved in pot melting by thimble-type stirrers for making optical glass. A propeller-type stirrer has been used through the bottom of a continuous tank with good results.

Electrothermal stirring is accomplished by electrodes which are operated at high current densities or high contact resistance. The glass at an electrode can be made 100°F. hotter than the surrounding glass, and, therefore, a local convection current results. This comes within the definition of small scale turbulence.

The third method of creating such turbulence is by bubbling. Air or other gases introduced through the bottom of a furnace will rise and carry a portion of the glass upward, out of the laminar convection flow pattern.

These methods are all good. The mechanical stirrer

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is somewhat difficult to install and has not found wide usage.

The electrical method has been applied broadly, sometimes by itself for cord control only, but most often in conjunction with boosting for increased tonnage.

The bubbling system has also been applied broadly for the correction or creation of convection currents, as well as for local turbulence. When creation of convection currents has been the objective (that is, the furnace was not giving good performance), bubbling has given important increases in tonnage, as well as control of cords.

When cord control is the important factor, bubbling is the cheapest to install and operate.

Cases were cited with furnaces of the same size melting 70 tons per day of amber, and 90 tons per day of flint, respectively. Bubblers were installed for the purpose of reducing the firing temperature and guarding against occasional unexplained upsets in glass homogeneity that had occurred in the past.

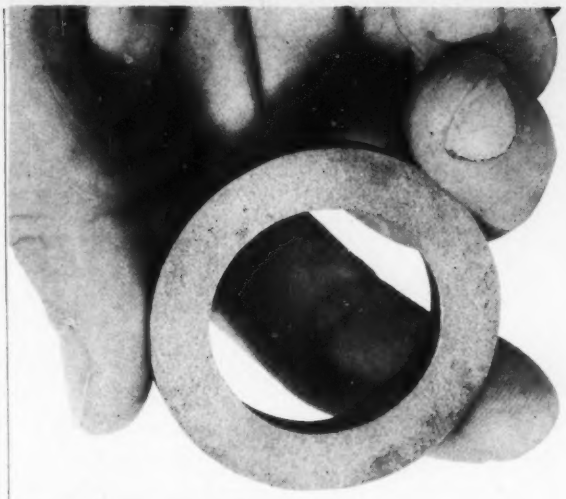
Gas was reduced about 6 per cent at the same tonnage, and the superstructure temperature was brought down 60°F. The quality remained good as to seed and improved as to homogeneity. The crowning payoff came three weeks later when there was a sudden dip in density which was severe enough to have indicated cord trouble from previous experience. Instead, the quality stayed high, and there was no trouble.

Another case was cited in which a large furnace was used to melt dark green glass. There was considerable trouble with intermittent severe cords. The glass was highly variable, often dropping to D and E grade homogeneity. The remedy was to put in a bubbler installation. By careful control of the intensity of bubbling, the cord rating was kept consistently B to B plus and better.

In bubbling installations a careful regulating arrangement is provided, but the signal comes from the temperature of the glass 6 inches from the bottom near the bridgewall. The sensing device is a closed end target tube which goes through the side wall and projects into the glass 12 inches. The temperature is read by a radiation pyrometer head or by a hand optical pyrometer. Measurements made with this device show temperatures within a range of 1850-1950°F. before the bubbling is turned on. After bubbling is started, the temperature of the glass on the bottom can be brought up to 2350°F. where it should be.

As a further control of cords it was recommended that the volume of glass in the working end of a tank be reduced to a minimum. A depth of 8 inches is quite sufficient. This will eliminate the stagnant glass present in a deep-working end, which is only a source of cord trouble.

In conclusion, bubbling and electric boosting have gone through a reasonable trial period now, and can be considered as standard tools of glassmaking.



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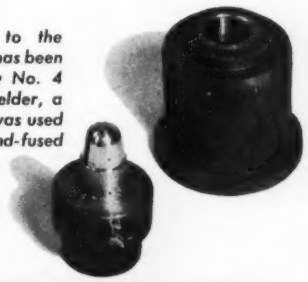

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